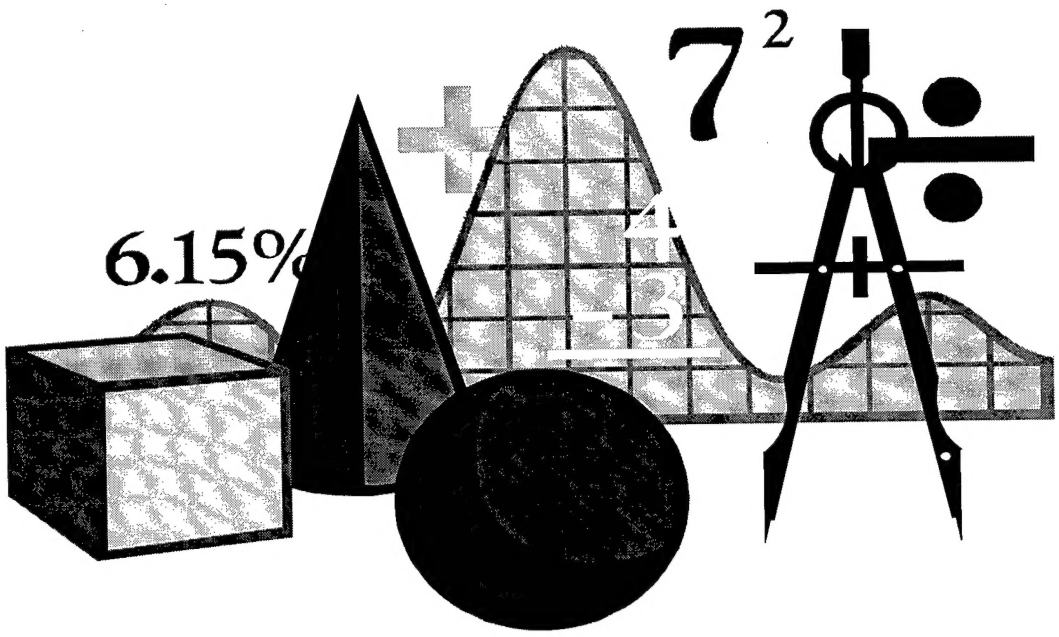
Department of the Army

Cost Analysis Manual



U.S. Army Cost and Economic Analysis Center

July 1997

FOREWORD

A major objective of the Army's Cost and Economic Analysis Program is to improve the justification and documentation used to effectively allocate and manage Army resources. To attain this objective, we must develop more accurate cost and economic analyses of Army programs, materiel systems, installations, facility acquisitions, automated information systems, forces, and activities. This manual provides basic frameworks for methodologies and procedures to implement policies for better cost analyses. The specific goal of this manual is to help the cost analyst serve the customer.

This manual is the result of the combined efforts of the Headquarters Department of the Army, the Major Commands, and Program Executive Officers. The format is designed to facilitate updating and expanding the manual, as necessary. Therefore, this publication should be considered a "living document" which will serve as a vehicle to disseminate current cost and economic analysis guidance. This is a continuing effort; additional or revised materiel will be forwarded as it is completed.

I believe you will find this edition of the **Cost Analysis Manual** a valuable and useful aid in understanding and participating in the cost and economic analysis process. Your ideas and suggestions for improving this manual are always welcome. Comments and suggested improvements may be provided to Director, U.S. Army Cost and Economic Analysis Center, ATTN: SFFM-CA-PA, 5611 Columbia Pike, Falls Church, VA 22041-5050, phone (703) 681-3350 or DSN 761-3350.

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CHAPTER 1 - INTRODUCTION

1- 1. Purpose

a. This manual provides basic methodologies and procedures for implementing cost analysis policies. It is one part of the essential set of instructions for analysts working in the cost and economic analysis area. Another part, Army Regulation (AR) 11-18, The Cost and Economic Analysis Program, specifies the policies and responsibilities for cost and economic analysis throughout the Army. The last part, Department of the Army Economic Analysis Manual, provides the methodologies and procedures for implementing economic analysis policies.

b. The specific goal of this manual is to help the cost analyst serve the customer. This is done by providing reference material on cost analysis processes, methods, techniques, structures, and definitions. It covers special analyses, review procedures, and selected common cost analysis topics. In addition, this manual provides a structure for materiel systems composed of system-specific, appropriation-discrete, and time-sensitive cost elements. Lastly, it presents accepted documentation standards.

c. This manual supersedes the Department of the Army Cost Analysis Manual dated August 1992.

d. Department of Defense Directive (DoDD) 5000.1 and Department of Defense (DoD) Regulation 5000.2-R describe the current defense acquisition process. They are the basis for the frameworks in this manual. Included is a framework for the development, documentation, and presentation of materiel systems' life cycle cost estimates. Specifically addressed are the requirements for a program office estimate (POE), component cost analysis (CCA), cost analysis brief (CAB), and other cost analysis documents. Also, the manual provides a framework for the development, documentation, and presentation of force cost estimates.

e. This manual contains useful information for those who help in providing data for cost analysis purposes. It also helps those who use the results of cost analysis.

1- 2. References

Appendix A lists the required and related publications.

1- 3. Explanation of abbreviations and terms

The glossary explains the abbreviations and special terms used in this manual.

1- 4. Introduction to cost analysis

a. Cost analysis is:

(1) The act of developing, analyzing, and documenting cost estimates using analytical approaches and techniques.

(2) The process of analyzing and estimating incremental and total resources required to support past, present, and future forces, units, systems, functions, and equipment. It is an integral step in the selection between alternatives by the decision maker.

(3) A management tool used to help decision makers evaluate resource requirements at key management milestones and decision points in the acquisition process.

b. Cost analysis is used to produce cost estimates for materiel systems, automated information systems, force units, training, and other Army programs and projects.

c. Each cost analysis should contain:

(1) A clear definition of what is being costed.

(2) The specification of all assumptions, ground rules, and constraints, assumed or imposed, underlying the analysis. They must each be explained with adequate rationale.

(3) An estimate of all expected costs, directly or indirectly associated with the project over its life, including disposal. The cost estimate must include the identification of all data sources used.

(4) Risk and uncertainty analyses identifying any circumstances which could affect a course of action.

(5) Key limitations in terms of elements that were excluded.

d. The documentation supporting the cost analysis should describe the methodology used in developing these estimates. It also should identify all the data sources and include the computations used to estimate the costs. The documentation should be in sufficient detail to permit reviewers to follow the logic from assumptions to conclusion and to update the estimate at a later time. Chapter 4 presents documentation formats and a set of presentation matrices for materiel systems.

1- 5. Cost analysis requirements, uses, and limitations

a. Cost analysis is a critical element in the Army acquisition process. It supports management decisions by quantifying the resource impact of alternative options. A quality analysis includes different acquisition strategies, hardware designs, software designs, personnel requirements, and operating and support concepts.

b. As a program matures and more information becomes available, the cost estimate grows in complexity and detail. One test of the utility of cost analysis is its ability to respond quickly to program turbulence. Army planners must have reliable, quickly available information about the cost consequences of program changes, extensions, or cancellations. Cost analysts must develop models to support these quick turnaround analyses.

c. Cost analysis plays a key role in budgeting the Army's operating tempo (OPTEMPO) related training costs. The Army's implementation of the DoD Visibility and Management of Operating and Support Costs (VAMOSC) program is the Operating and Support Management Information System (OSMIS) and the Army Military-Civilian Cost System (AMCOS). The U.S. Army Cost and Economic Analysis Center (CEAC) manages the OSMIS program including developing and reporting reparable and consumable OPTEMPO costs for selected tactical systems by major command (MACOM). The development of the training mission budgets requires reliable OPTEMPO cost factors. AMCOS is a database, which provides personnel cost factors for estimating acquisition, installation operations and force/unit requirements.

d. Cost analysis has an on-going role in the management of base operations. Cost analysis assists installations, MACOMs and HQDA in determining base support requirements, developing budgets, conducting cost benefit analysis, and performing special studies. At the HQDA level, CEAC develops cost factors in support of the Army Chief of Staff for Installation Management (ACSIM) for both the Installation Status Report (ISR) and the Army Installation Management - Headquarters Information (AIM-HI) model. Other ACSIM efforts supported by cost analysis include A-76 studies, Service Based Costing, and Standard Service Costing.

With the establishment of the cost/outcome oriented Government Performance Results Act (GPRA), cost analysis has taken on a larger role in to support management of base operations. The managerial costing focus, to meet GPRA mandates, requires cost analysis in the measuring and management of cost and results. Cost analysis will be needed to develop methodologies, conduct studies and analyze data of the products and services provided through base operations. The prerequisite to cost management is cost measurement. There are numerous methods of measuring costs, all of which will require cost analysis skills now and in the future. Examples of cost measurement include, full cost, job-order cost , service based cost, activity based cost, standard cost, product cost, and responsibility cost to name a few. Though there are many examples of cost measurement each demands cost analysis support to make information meaningful to Army management. CEAC will prepare a managerial costing manual in the future on Activity Based Costing, Service Based Costing and Standard Service Costing.

e. Other uses of cost analysis in the Army are to:

(1) Support decisions on program viability, structure, and resource requirements.

(2) Evaluate the cost implications of alternative materiel system designs.

(3) Provide credible and auditable cost estimates in support of milestone reviews during the acquisition process.

(4) Assess the cost implications of new technology, new equipment, new force structures, or new operating or maintenance concepts.

(5) Support the Planning, Programming, Budgeting, and Execution System (PPBES) process. This includes formulating and documenting Army cost positions on programs within the Program Objective Memorandum (POM) and the budget estimate submission (BES) processes.

(6) Determine the funds required for a given level of training or operational activity such as miles driven per year.

e. Cost analysis applies scientific and statistical methods to evaluate the likely cost of a specific item in a defined scenario. In the real world, there are multiple uncertainties about the item's cost. Some "internal" uncertainties influencing cost are inadequate item definition, poor contract statement of work, optimistic proposed solutions, inexperienced management, and success-oriented scheduling. Some "external" uncertainties include funding turbulence, contractor's underestimating of complexity, contractor's changing business base, and excessive (or insufficient) Government oversight. In spite of uncertainty, the process of cost analysis is the most rigorous approach available to evaluate the costs of alternatives for the decision maker.

f. Cost analysis does have limitations. Analysts develop cost estimating methodologies with an imperfect understanding of the technical merits and limitations of the item. The applicability of historic data is always subject to interpretation. Because of future uncertainties, there are limitations in determining the degree to which reality varies from the plan. Realistically, the cost analysis process **cannot**:

(1) Be applied with cookbook precision, but must be tailored to the problem.
(2) Produce results that are better than input data.
(3) Predict political impacts.
(4) Substitute for sound judgment, management, or control.
(5) Make the final decisions.

g. Despite these limitations, cost analysis is a powerful tool. Rigorous and systematic analysis leads to a better understanding of the problem. It improves management insight into resources allocation problems. Because the future is uncertain our best estimate will differ from reality.

1- 6. Cost analysis training

Continuing education in cost analysis is crucial to the critical mission of providing Army decision makers with quality, timely cost analysis. DoD agencies provide several excellent training programs. Appendix C presents a partial list of current training courses.

1- 7. Internal control

The Cost Review Board (CRB) process (see paragraph 4-4c) is an evaluation method for internal control (AR 11-2, Management Control). The CRB process provides an independent review of the cost of ACAT I and special interest ACAT II programs, safeguards assets, checks the accuracy and reliability of cost data, promotes efficiency within the discipline of cost analysis, and encourages adherence to prescribed cost analysis managerial policies.

1- 8. Cost analysis advice/aid

As the proponent for the Army's cost analysis program, CEAC is available to provide advice/aid. Questions may be addressed to Director, U.S. Army Cost and Economic Analysis Center, ATTN: SFFM-CA-PA, 5611 Columbia Pike, Falls Church, VA 22041-5050, phone (703) 681-3350 or DSN 761-3350. Additional information is available on the ASA(FM&C) home page (www.asafm.army.mil).

CHAPTER 2 - INTERRELATIONSHIPS

2- 1. Introduction

This chapter provides an overview of the cost analysis interrelationships with three processes. They are the defense acquisition process, the DoD Planning, Programming and Budgeting System (PPBS) process, and the contract process. The Army' process, Planning, Programming, Budgeting and Execution System (PPBES) adds emphasis to efficient management execution of the allotted resources.

2- 2. Interrelationship with the defense acquisition process

a. Introduction

(1) Cost analysis is an integral part of the acquisition process. This section provides an introduction to the defense acquisition process and identifies the cost analysis that it uses.

(2) DoDD 5000.1, Defense Acquisition, states policies and principles for all DoD acquisition programs and identifies the Department's key acquisition officials and forums. DoD 5000.2-R, Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs, establishes a general model for managing MDAPs and MAIS acquisition programs. The principal thrust of DoDD 5000.1 and DoD 5000.2-R is a disciplined yet flexible management approach for acquiring quality products that satisfy the operational user's needs and effectively translates operational needs into stable, affordable acquisition programs. The Army implements the DoDD 5000.1 and DoD 5000.2-R in AR 70-1, Army Acquisition Policy.

b. Document summaries

Key elements impacting Army cost analysis are summarized below.

(1) DoDD 5000.1

(a) Applies to the management of major and non-major programs and to highly sensitive classified programs. The Services cannot supplement DoDD 5000.1 without Office of the Secretary of Defense (OSD) approval and must keep implementing directives to a minimum.

(b) Presents the policies and principles that govern the operation of the defense acquisition system. These policies and principles are divided into three major categories: (1) Translating Operational Needs into Stable, Affordable Programs, (2) Acquiring Quality Products, and (3) Organizing for Efficiency and Effectiveness.

(2) DoD 5000.2-R

(a) Establishes a simplified and flexible management framework for translating mission needs into stable, affordable, and well-managed MDAPs and MAIS Acquisition Programs;

(b) Sets forth mandatory procedures for MDAPs and MAISs and, specifically where stated, for other than MDAPs or MAISs;

(c) Serves as a general model for other than MDAPs or MAISs;

(d) Consistent with statutory requirements, authorizes Milestone Decision Authorities (MDAs) to tailor the procedures as they see fit;

(e) Implements (reference (a)) the guidelines in DoD Directive 5000.1 and OMB Circular A-109 current statutes;

(f) Authority to change this Regulation has been delegated to the Under Secretary of Defense for Acquisition and Technology (USD(A&T)); Director, Operational Test & Evaluation; and Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD(C3I)). All future changes shall be jointly signed by these three officials.

(3) AR 70-1

(a) Implements DoDD 5000.1, DoD 5000.2-R, DoDD 5000.52, DoD 5000.52-M and Department of Defense Instruction (DoDI) 5000.58.

(b) Governs research, development, and acquisition, and Life Cycle Management (LCM) of Army materiel to satisfy approved Army requirements and applies to major systems, non major systems, highly sensitive classified acquisition programs, automated information systems, and clothing and individual equipment.

(c) First in order of precedence for managing Army acquisition programs following statutory requirements, DoD guidance, Federal Acquisition Regulation, and Defense and Army Federal Acquisition Regulation Supplements.

c. Milestones and phases

OSD structured the acquisition process into major decision points called milestones (MS 0 through III). The milestone review process provides a framework for comparing military goals. The Integrated Product Team (IPT) process allows for tailoring the documentation presented at each review to meet the specific program's needs. All programs must achieve goals (threat, requirements, affordability, acquisition strategies, life cycle costs, cost-performance-schedule tradeoffs, and risk management). Figure 2-1 shows this process.

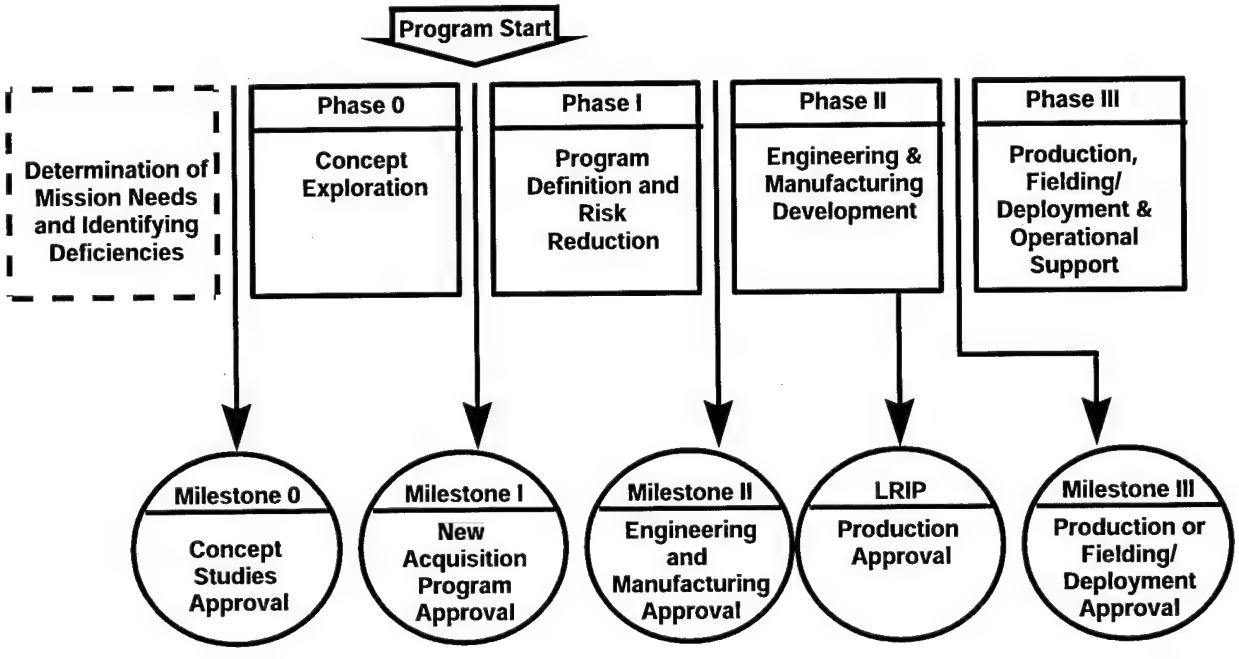


Figure 2-1. Acquisition Milestone and Phases

Tables 2-2 through 2-10 summarize key descriptors for each milestone and phase of the acquisition process.

Table 2-1. Acquisition Categories (ACATs)

ACAT	SELECTION CRITERIA	DESIGNATION AUTHORITY	MILESTONE DECISION AUTHORITY	
I	Not classified as highly sensitive by SECDEF that are: Designated ACAT I by USD(A&T), or Estimated by USD(A&T) to require: >$355M (FY96 $) RDT&E or >$2.135B Procurement (FY96 $)	USD(A&T)	**ACAT ID** USD(A&T)	**ACAT IC** Secretary of the Army (SA) or, if delegated, Army Acquisition Executive (AAE)
IA	Designated ACAT I by ASD(C3I), or Estimated by ASD(C3I)) to require: >$30M (FY96$) single year or >$120M (FY96$) total program or >$360M (FY96$) total life-cycle costs	ASD(C3I)	**ACAT IAM** ASD(C3I))	**ACAT IAC** AAE/Army CIO
II	Does not meet ACAT I criteria and are: Designated ACAT II by SA, or Estimated by SA to require: >$135M RDT&E (FY 96 $), or >$640M Procurement (FY 96 $)	SA	ASD(C3I))	
IIA	Designated ACAT II by AAE/Army CIO, or Estimated by Army CIO to require: >$10M (FY96$) single year or >$30M (FY96$) total program or >$159M (FY96$) total life-cycle		AAE/Army CIO	
III	Does not meet ACAT I, IA and II criteria and are designated ACAT III by AAE. High visibility, special interest programs	AAE	Lowest level deemed appropriate by AAE	
IIIA	Designated ACAT II by AAE/Army CIO, or Estimated by Army CIO to require: <$10M (FY96$) single year or <$30M (FY96$) total program or <$159M (FY96$) total life-cycle		Lowest level deemed appropriate by AAE	
IV	All other acquisition programs (including AIS)		Lowest level deemed appropriate by AAE	

Table 2-2. Milestone 0—Concept Studies Approval

DECISION CRITERIA
• A validated Mission Need Statement (MNS) • Satisfying the need with a nonmateriel solution • Whether the need is sufficiently important to warrant funding of study efforts • Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) support requirement • For an ACAT IA program, an Analysis of Alternatives (AOA)
ACQUISITION DECISION MEMORANDUM
• Define the minimum set of alternative concepts to be examined • Identify lead organization for study efforts • Identify dollar/source of funding for study efforts

Table 2-3. Phase 0—Concept Exploration

OBJECTIVES
• Explore various materiel alternatives to satisfying mission need • Define most promising system concept(s) • Develop supporting information, including risk areas and risk management approaches • Develop acquisition strategies and program cost, schedule, and performance objectives for most promising concept(s)
MINIMUM REQUIRED ACCOMPLISHMENTS
• Creation of validated assessment of the military threat * • Consideration of technology and technical risk • Assessment of advantages and disadvantages of each alternative concept • Identification of an acquisition strategy • Identification of cost, schedule, and performance for approval • Identification of potential environmental consequences * • Identification of program specific accomplishments to be completed during the next phase • Analysis of any major technology and industrial capability issues * • Identification of cooperative opportunities * • Ensuring compliance with international arms control agreements* • Creation of proposed oversight & review strategy including description of mandatory program information and when this information needs to be submitted for next milestone decision • Development of the system requirement in terms of measures of effectiveness (MOE), measures of performance (MOP), and C4ISR support requirement * Normally not applicable to ACAT IA programs

Table 2-4. Milestone I—New Acquisition Program Approval

DECISION CRITERIA
• Threat assessment * • Acquisition Strategy • CAIV life cycle-based objectives • Phase 0 exit criteria status and Phase I exit criteria plans • APB • AOA and studies supporting need for new program • Environmental consequences * • Adequacy of resources (manpower and funding) • Hierarchy of materiel alternatives * • Affordability assessment • Updated C4ISR support requirement * Normally not applicable to ACAT IA programs
ACQUISITION DECISION MEMORANDUM
• Approve the initiation of a new program and entry into Phase I • Approve the APB and the acquisition strategy

Table 2-5. Phase I— Program Definition and Risk Reduction

OBJECTIVES
• Identify and reduce risk • Assess if most promising design approach(es) will operate in intended operational environment including both people and conditions. • Identify possible cost-saving changes that affect key Operational Requirements Document (ORD) and APB performance parameters • Establish proposed performance objectives • Identify production rate requirements for peacetime, contingency support, and reconstitution objectives • Develop proposed cost-schedule-performance trade-offs for decision at Milestone II
MINIMUM REQUIRED ACCOMPLISHMENTS
• Creation of updated assessment of the military threat * • Consideration of technology and technical risk • Refinement of cost objectives and affordability assessment • Identification of major cost, schedule, and performance tradeoff opportunities • Acquisition strategy refinement & initial low-rate initial production quantities determination * • Identification of a test and evaluation strategy and appropriate testing • Assessment of the industrial capability to support the program * • Proposed cost, schedule, and performance objectives identification and thresholds for approval • Assessment of potential environmental impacts * • Verification that adequate resources have been programmed to support production, deployment, and support • Identification of cooperative opportunities * • Ensuring of compliance with international arms control agreements* • Creation of a proposed oversight and review strategy to include a description of mandatory program information and when this information needs to be submitted for the next milestone • Refinement of CAIV objectives • Analysis of any major technology and industrial capability issues • Creation of Independent Cost Estimate (ICE) and Manpower Estimate • Refinement of C4ISR support requirements * Normally not applicable to ACAT IA programs

Table 2-6. Milestone II—Engineering, Manufacturing & Development Approval

DECISION CRITERIA
• Acquisition strategy • CAIV progress • APB • Phase I exit criteria status and Phase II exit criteria plans • Low-Rate Initial Production (LRIP) quantities * • Validated threat assessment * • Prototyping/demonstration results • Potential environmental consequences • Adequacy of resources (manpower and funding) • ICE and Manpower Estimate • Updated C4ISR support requirement * Normally not applicable to ACAT IA programs
ACQUISITION DECISION MEMORANDUM
• Approves entry into Phase II (Engineering and Manufacturing Development) • Approves the proposed or modified APB and acquisition strategy • Establishes life-cycle cost objectives • Exit criteria • Identifies LRIP quantities (if appropriate) • The LRIP strategy, required information, and decision authority is normally considered at this milestone.

Table 2-7. Phase II—Engineering and Manufacturing Development (EMD)

OBJECTIVES
• Translate most promising design into a stable, producible, and cost-effective system design • Validate manufacturing or production process • Demonstrate through testing that system capabilities: - Meet contract specification requirements - Satisfy mission need and minimum acceptable operational performance requirements
MINIMUM REQUIRED ACCOMPLISHMENTS
• Achievement of design stability • Consideration of technology and technical risk • Design, coding, integration, and testing of software • Creation of updated assessment of the military threat * • Creation of an updated test program with required lethality and survivability testing * • Production of Initial Operational Test and Evaluation (IOT&E) results that realistically portray operational performance • Identification of a refined acquisition strategy to include support concept • Creation of a refined program cost estimate, independent cost estimate, cost objectives and Manpower Estimate • Creation of an updated affordability assessment • Assessment of the technological and industrial capability to support the program * • Identification of proposed cost, schedule, and performance objectives and thresholds for approval • Assessment of potential environmental impacts * • Verification that adequate resources have been programmed to support production, deployment, and support • Identification of cooperative opportunities * • Ensuring compliance with international arms control agreements* • Creation of a proposed oversight and review strategy to include a description of mandatory information and when this information needs to be submitted for the next milestone • Refinement of CAIV objectives • Refinement of C4ISR support requirement * Normally not applicable to ACAT IA programs

Table 2-8. Low-Rate Initial Production (LRIP)

OBJECTIVES
• The determination of the LRIP quantity should consider - Fabrication complexity of the system - relatively small number to be procured and high unit cost - length of the production period - need to preserve the industrial base for the system - acquisition strategy that is most advantageous to the Government
DECISION CRITERIA
• Acquisition strategy * • APB * • Phase II exit criteria * • Threat assessment * • Test results * • Initial production experience * • Environmental consequences * • CAIV progress • Adequacy of resources (manpower and funding) * • Updated C4ISR support requirement • ICE and Manpower Estimate * Normally not applicable to ACAT IA programs

Table 2-9. Milestone III—Production Approval

DECISION CRITERIA
• Acquisition strategy • APB • Phase II exit criteria • Threat assessment * • Test results • Initial production experience * • Environmental consequences * • Cost as an Independent Variable (CAIV) progress • Adequacy of resources (manpower and funding) • ICE and Manpower Estimate • Updated C4ISR support requirement * Normally not applicable to ACAT IA programs
ACQUISITION DECISION MEMORANDUM
• Approve entry into Phase III (Production, Fielding/Deployment, and Operational Support) • Approve proposed or modified acquisition strategy and production APB • Establish exit criteria

Table 2-10. Phase III—Production and Deployment

OBJECTIVES
• Assess the ability of the system to perform as intended • Identify and incorporate into production lots, minor engineering change proposals to meet required capabilities • Identify the need for major upgrades or modifications • Support plans should be implemented to ensure support resources are acquired and deployed with the system.
MINIMUM REQUIRED ACCOMPLISHMENTS
• Full rate production experience that verifies manufacturing and production processes, confirms the stability and producibility of the design, and provides realistic production cost estimates * • Creation of a refined configuration management program • Creation of an updated and validated assessment of the military threat * • Creation of refined life cycle cost estimates • Execution of operational and support plans, to include transition from contractor to in-house support, if appropriate • Identification of operational and support problems • Resolution of system deficiencies and verification thereof in Demonstration, Test and Evaluation and Full Operational Test and Evaluation, if appropriate • Refinement of C4ISR support requirement * Normally not applicable to ACAT IA programs

d. Required acquisition documents

The decision authority shall, as a minimum, review a program's progress at MS I through MS III. Documentation is the primary means for the functional staff and program manager (PM) to provide the decision authority with the information needed to make a milestone decision. Under the IPT process, documentation other than the required statutory documents, should be tailored to meet the needs of the decision authority. The scope and formality of this documentation will vary depending on the program's ACAT. However, ACAT I and II programs, subject to a particular statutory document must use the required formats. At their discretion, the Services may require ACAT II, III and IV programs to use requisite formats (ACAT IV is peculiar to the Army). Figure 2-2 summarizes milestone documentation. The purpose of program status reporting is to provide the decision authority with adequate information to oversee the program. Also, management-by-exception is the basis for program status reporting, which is limited to those reports required by statute and DoD 5000.2-R. The scope and formality of reporting requirements will vary depending on the program's ACAT and the IPT's recommendations. Figure 2-3 summarizes periodic reports and certifications.

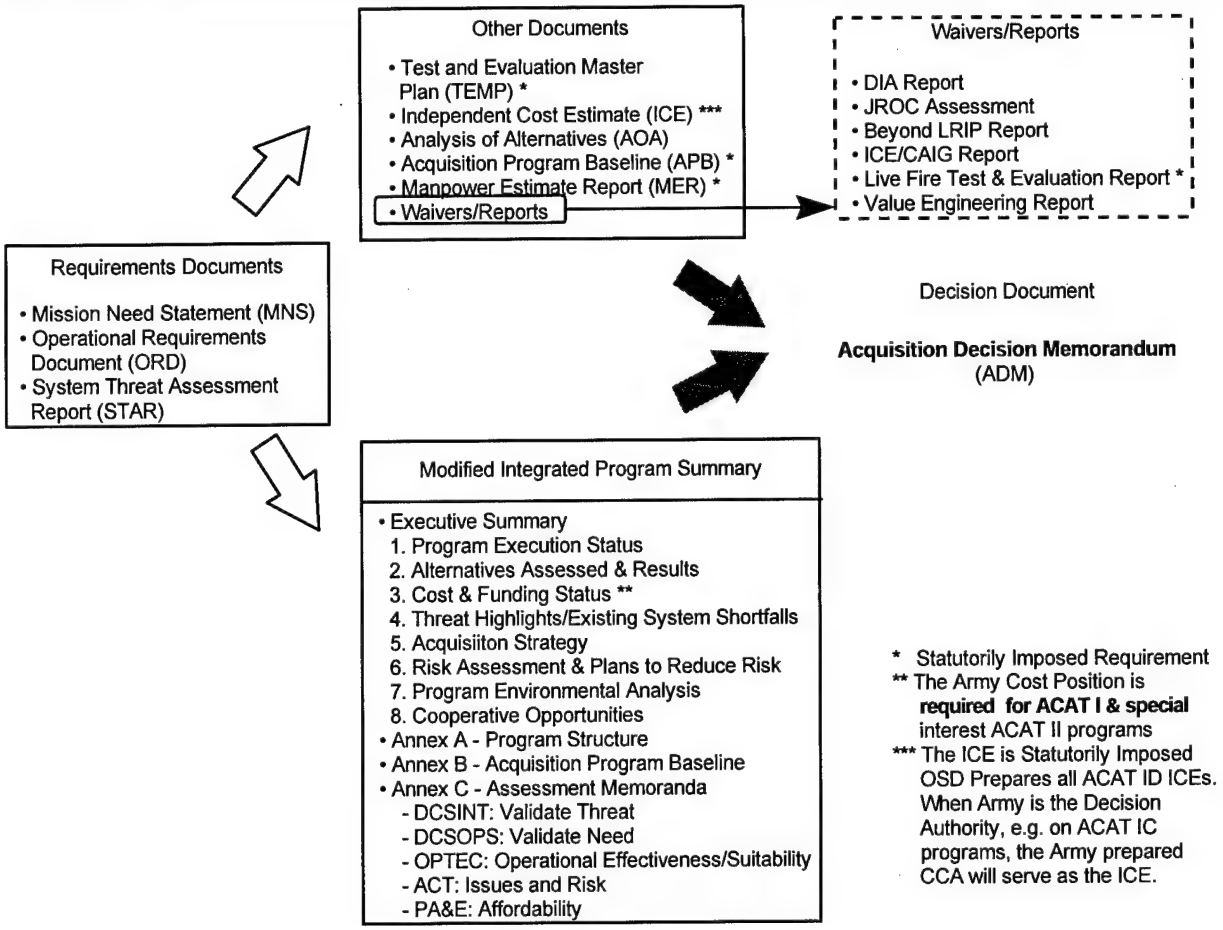


Figure 2-2. Milestone Documentation

e. Defense Acquisition Board (DAB)

(1) The DAB is the senior DoD acquisition review board chaired by the USD(A&T). The DAB advises the USD(A&T) on major decisions on individual acquisition programs.

(2) The DAB convenes for all potential ACAT I programs at MS 0 and all ACAT I program new starts at MS I. A DAB is scheduled for the milestones on ACAT ID programs and the USD(A&T) request a DAB to hold a special program reviews between milestones. Examples are baseline changes, release of withheld funds, and acquisition strategy changes.

(3) Approximately one week prior to the DAB review, a DAB Readiness Meeting (DRM) shall be held to pre-brief the USD(A&T), Vice Chairman, Joint Chiefs of Staff (VCJCS), and the other DAB participants (including cognizant Program Executive Officer(s) (PEO(s)) and PM(s). The purpose of the meeting is to update the USD(A&T) on the latest status of the program and to inform the senior acquisition officials of any outstanding issues. Normally, the Overarching Integrated Product Team (OIPT) Leader shall brief the DRM. If outstanding issues are resolved at the DRM, the USD(A&T) may decide that a formal DAB meeting is not required and issue an Acquisition Decision Memorandum (ADM) following the DRM. ADMs shall be coordinated with the DAB Principals.

(4) Briefings by the PM during the process leading to the DAB are limited to those essential to the process. Figure 2-4 shows the DAB milestone time line and briefing requirements.

f. Army program reviews

(1) The Army Systems Acquisition Review Council (ASARC) is the Army's senior-level review authority for ACAT I and ACAT II programs. It recommends appropriate action to the Army Acquisition Executive (AAE) and the Vice Chief of Staff, Army (VCSA) for decisions or recommendation to the DAB. At meetings of the ASARC, members hold face-to-face discussions of program issues leading to a recommended ACP. Decisions/guidance provided at an ASARC may cause revisions to the program documentation and baseline, including program cost documents. The purpose of the pre-ASARC, normally held 3 to 4 weeks before the ASARC meeting, is to define remaining open issues and set the ASARC agenda. The ACP is available at the pre-ASARC to highlight any cost issues resulting from the POE/CCA and associated PPBES reviews.

(2) An in-process review (IPR) is the decision review body for all ACAT III and ACAT IV programs. These reviews, held before each milestone, provide recommendations for decision by the milestone decision authority. The decision authority will identify an IPR chairperson. The general policies and documentation requirements for an IPR program are the same as for ASARC programs. The life cycle cost estimate is a key decision document. No Army Cost Position is developed for ACAT III & IV programs. The milestone decision authority may require pre-IPR reviews. It is critical for the cost analyst to highlight any cost issues resulting from the POE/CCA and associated PPBES reviews.

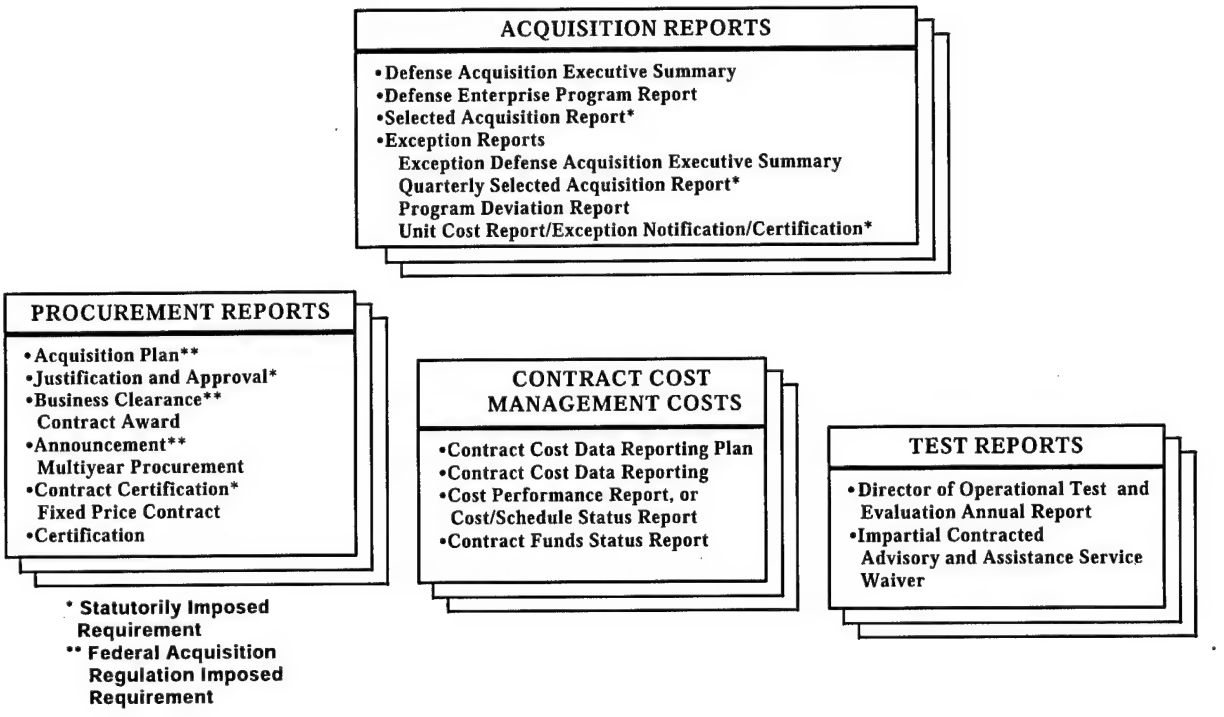


Figure 2-3. Periodic Reports and Certifications

(3) The decision authority sets the policy on decision reviews for special access programs (SAPs). To limit dissemination of program information, reviewing activities will follow AR 380-381, Special Access Programs. The general policies and documentation requirements for an SAP are the same as for ASARC programs. It is critical for the cost analyst to highlight any cost issues resulting from the POE/CCA and associated PPBES reviews.

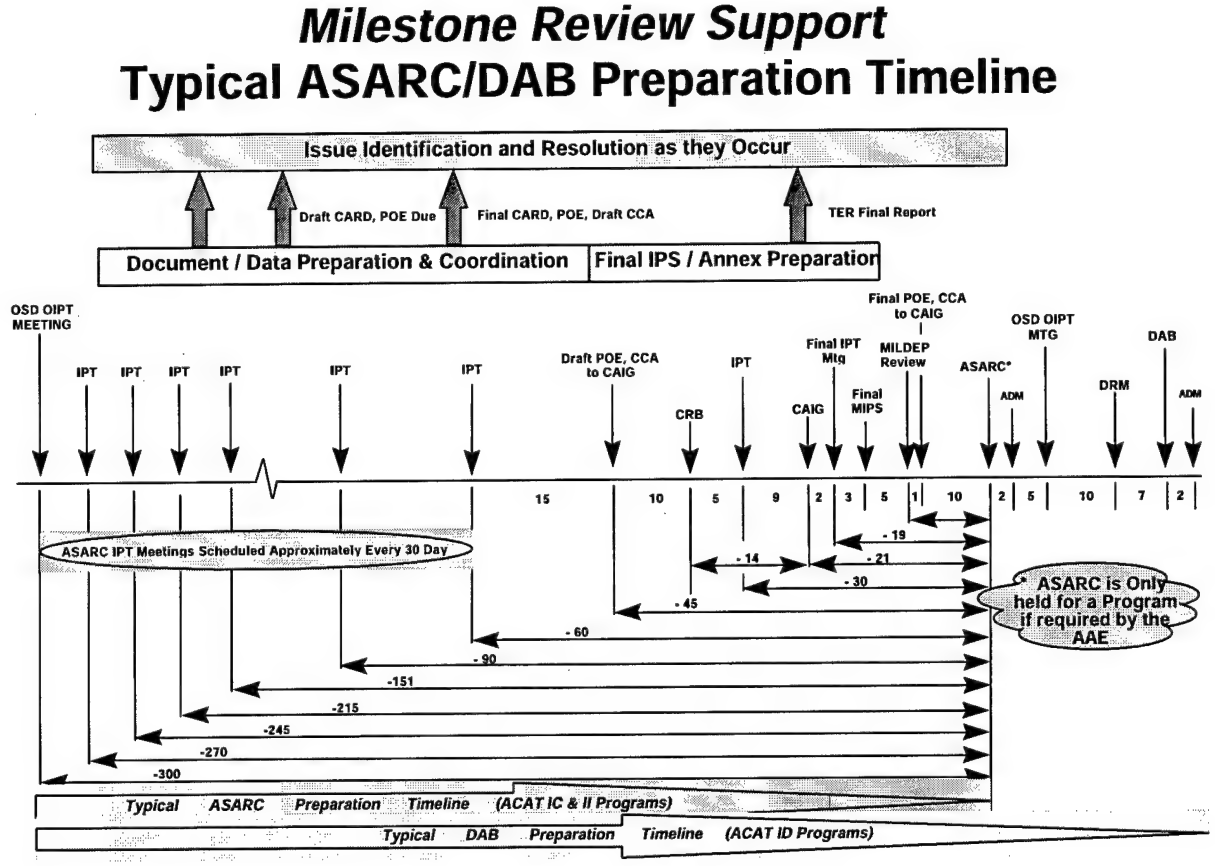


Figure 2-4. Typical ASARC/DAB Milestone Timeline

g. Key cost analysis interfaces

(1) Analysts prepare cost estimates in support of MS I and all later milestones. These estimates provide a comprehensive and realistic snapshot of the definition and relationships between program goals, requirements, and contractual specifications. The Program Office (PO) normally prepares one cost estimate, while an organization outside the acquisition chain may prepare a second, independent estimate. The independent estimate, called a Component Cost Analysis, is prepared by CEAC when requested by the AAE. When a Joint-Service organization manages a program, the decision authority appoints an organization to prepare the CCA and/or the ICE. As warranted by the issues involved, program reviews may require cost estimates. Under the IPT process, a joint estimate may be prepared by the Cost Working-level IPT (WIPT).

(2) Analysis of Alternatives (AOA) provide a comparison between the cost and operational parameters of a program and one or more alternative programs. AOA also provide a structure to review design, acquisition, and life cycle cost options. Their primary benefit occurs during the conceptual phase of the

acquisition life cycle. However, AOAs can provide later insight during the Cost as an Independent Variable process (See Section 3-7). It is during this phase when Army planners have the most flexibility to influence important design or hardware configurations. Analysts perform system tradeoff analysis using AOA or updates for ACAT I and II programs at each milestone. For other programs, analysts should tailor AOAs as directed by the AAE.

(3) The Cost as an Independent Variable (CAIV) process involves setting challenging life cycle cost goals during the development phase or the introduction of major modifications. It also involves the management of the program to reach these goals. The primary management tool used is tradeoff analysis of system capability, performance, schedule, and cost. When treated as a design parameter, cost management helps to achieve goals throughout development and production in an economical and efficient manner. The Milestone Decision Authority approves the CAIV goals for ACAT I programs (others at the decision authority's discretion) beginning at MS I and updates them at successive milestones. CAIV focuses on identifying cost drivers, potential risk areas that may become cost drivers, and cost-schedule-performance tradeoffs. Later efforts focus on identifying and applying cost reduction techniques to areas of excessive costs.

(4) Systems must undergo a complete system review for design, manufacturing, and production. The purpose of the review is to ensure design consistency with initial technical requirements and production capability and efficiency. Production engineering and producibility efforts begin at MS I and focus on simplifying the design and stabilizing the manufacturing process. A rigorous assessment of product design and manufacturing process risks is essential to ensure quality and reduce life cycle cost. The cost analyst should compare design alternatives against performance measures, as well as associated life cycle cost. Each program should undergo a thorough design tradeoff analysis. The cost analyst's role in this process is to interpret the resources and risks associated with each competing design. This process begins during Phase 0 and continues through all phases. The decision authority will not approve full production until there is a stable design, a proven manufacturing process, and the production facilities are in place or planned.

(5) Managers develop tailored acquisition strategies to optimize the calendar time and cost of satisfying established requirements. These strategies evolve through an iterative process, becoming more definitive in describing the essential elements of a program.

(6) Managers are required to establish a risk management program with industry participation. The purpose is to identify and manage performance, cost, and schedule risks throughout the acquisition cycle.

(7) A disciplined acquisition process assures fielding reliable and maintainable systems. Throughout the process, program managers must maintain a comprehensive understanding of the user's system requirements, physical environment, and available resources. To reduce overall Army resource requirements, the program manager should continually focus on system reliability and maintainability.

(8) The AOA reviews a range of materiel concepts that satisfy a mission need before committing to a program new start. The requirement for investigating alternative materiel concepts arises when a system proposes:

(a) The use or modification of an existing U.S. military system.
(b) The use or modification of a commercial or allied system.
(c) A cooperative research and development (R&D) program with the allies.
(d) A Joint-Service program.
(e) A Service-unique program.

(9) Financial analyses provide a significant assessment of the potential financial risks associated with a contractors' operations.

2- 3. Interrelationship with the PPBS process

a. The DoD Planning, Programming, and Budgeting System (PPBS) is the primary system for managing the department's resources. It is also the parent system of the Army's Planning, Programming, Budgeting, and Execution System (PPBES). The purpose of the PPBS is to produce a plan, a program, and the defense budget. The Future Years Defense Program (FYDP) is the official summary of programs developed within the PPBS and approved by the Secretary of Defense (SECDEF). The FYDP lists resources by program element/project or SSN, resource identification code, FY, and value. The FYDP sums resource by appropriation. Under a 1987 statute, DoD must provide Congress with the FYDP underlying the President's budget.

b. PPBES serves as the Army's primary resource management system. Supporting the DoD PPBS, it is used to develop and maintain the Army's portion of the program at all levels of command. It supports execution of the approved program and budget by both headquarters and field organizations. During execution, it provides feedback to the planning, programming, and budgeting processes. The PPBES process is described in Army Regulation 1-1, Planning, Programming, Budgeting, and Execution System

c. Management Decision Packages (MDEPs)

(1) Currently, the Army uses MDEPs as a resource management tool. Early in the PPBES process, resource managers distribute program and budget resources to MDEPs. The distribution is by appropriation, standard study number (SSN), and program element (PE). Taken collectively, MDEPs account for all Army resources. They describe the capability of the Total Army (Active, Guard, and Reserve). Individually, an MDEP describes a particular organization, program, or function, and records the resources associated with the intended output. An individual MDEP applies uniquely to one of the following six management areas:

(a) Missions of Modified Table of Organization and Equipment (MTOE) units,

(b) Missions of Table of Distribution and Allowance (TDA) units and Army wide standard functions,

(c) Missions of Standard Installation Organizations (SIOs),

(d) Acquisition, fielding, and sustainment of weapon and information systems,

(e) Special Visibility Programs (SVPs),

(f) Short Term Projects (STPs).

Chapter 4 further discusses MDEPs as they relate to weapon system cost estimates.

(2) During programming, MDEPs provide useful visibility. They help Army managers, decision makers, and leaders assess program worth, confirm compliance, and rank resource claimants. During budgeting, MDEPs help convey approved programs and priorities into budget estimates. Providing the vehicle for data entry, MDEPs also help in tracking post-program changes caused by budget decisions and approved funding. During execution, the posted MDEPs help HQDA principal officials, MACOM commanders, PEOs, and heads of other operating agencies track program and financial performance. The financial data they get as feedback help determine future requirements.

d. Major PPBES documents

(1) Long-range planning looks 10 to 30 years ahead. In the process, the senior leadership of the Army creates a vision of the future Army. Commands and agencies then develop long-range plans to attain its concepts. The products of long-range planning guide the midterm vision used in developing the force and setting program requirements.

(a) Research, Development, and Acquisition Plan (RDA Plan). The RDA Plan is a continuous process focusing on a 15 year planning period (six Budget and POM years plus a nine-year Extended Planning Period). The RDA Plan process systematically focuses research, development, and acquisition programs on solving battlefield needs derived from war-fighting concepts.

(b) The Army Plan (TAP). The TAP documents policy of senior Army leadership and gives resource guidance. The TAP concurrently documents force levels stabilized initially through force requirements planning and then refined through objectives planning that results in a proposed program force. The Office of the Deputy Chief of Staff for Operations and Plans (ODCSOPS) drafts the TAP in coordination with the HQDA staff, MACOMs, and PEOs. Preparation occurs in three stages. First, ODCSOPS issues a preliminary TAP in December of the odd-numbered year. The preliminary TAP guides developing and updating a base force structured through a computer-assisted Total Army Analysis (TAA). As a minimum, the preliminary TAP codifies planning assumptions and sets parameters for modeling and structuring the program force. About 1 year later, in January of the next odd year, ODCSOPS issues the draft TAP. The draft TAP records the updated base force and revises planning assumptions given in the preliminary TAP as a basis for a Force Integration Analysis (FIA). Published as the resource section of the TAP, draft Army Program Guidance (APG) translates planning objectives into an initial plan of what the Army hopes to achieve in the next POM. The final version of the TAP appears the following June, after the FIA. The final TAP sets the preliminary program force approved by the Secretary of the Army (SA) and Chief of Staff, Army (CSA).

(c) Force development and TAA. The thrust of PPBES planning is to develop an attainable force structure for the Total Army that supports the national military strategy. The approach centers on the TAA process, which, led by ODCSOPS, includes HQDA agency and MACOM-PEO participation. The process gets under way about January of the even-numbered year. Then, in June of the odd-numbered year, ODCSOPS issues the final TAP, documenting the decision, making the preliminary program force the force structure basis for the Army program.

(2) Programming process and major documents

(a) Army programming helps the senior leaders assign resources to support Army roles and missions. Programming translates planning decisions, OSD programming guidance, and congressional guidance into a comprehensive and detailed allocation of forces, manpower, and funds. In the process, the PPBES integrates and balances centrally managed programs for manpower, operations, stationing, construction, and research, development, and acquisition. Concurrently, the PPBES incorporates requirements from the MACOMs and PEOs for manpower, operations and maintenance, housing, and construction. The result is the Army POM. The POM presents the Army's proposal for a balanced allocation of its resources within specified constraints. The Chairman's Program Assessment (CPA) evaluates the balance and capabilities of the composite force and support levels to attain national security objectives recommended by the Services' POMs. The CPA helps the SECDEF make program decisions. OSD reviews the Services' POMs, and issues Program Decision Memoranda (PDM) to reflect SECDEF program decisions. The Army POM, as approved by the SECDEF, provides the basis for the Army budget estimates submitted to OSD in the September time frame.

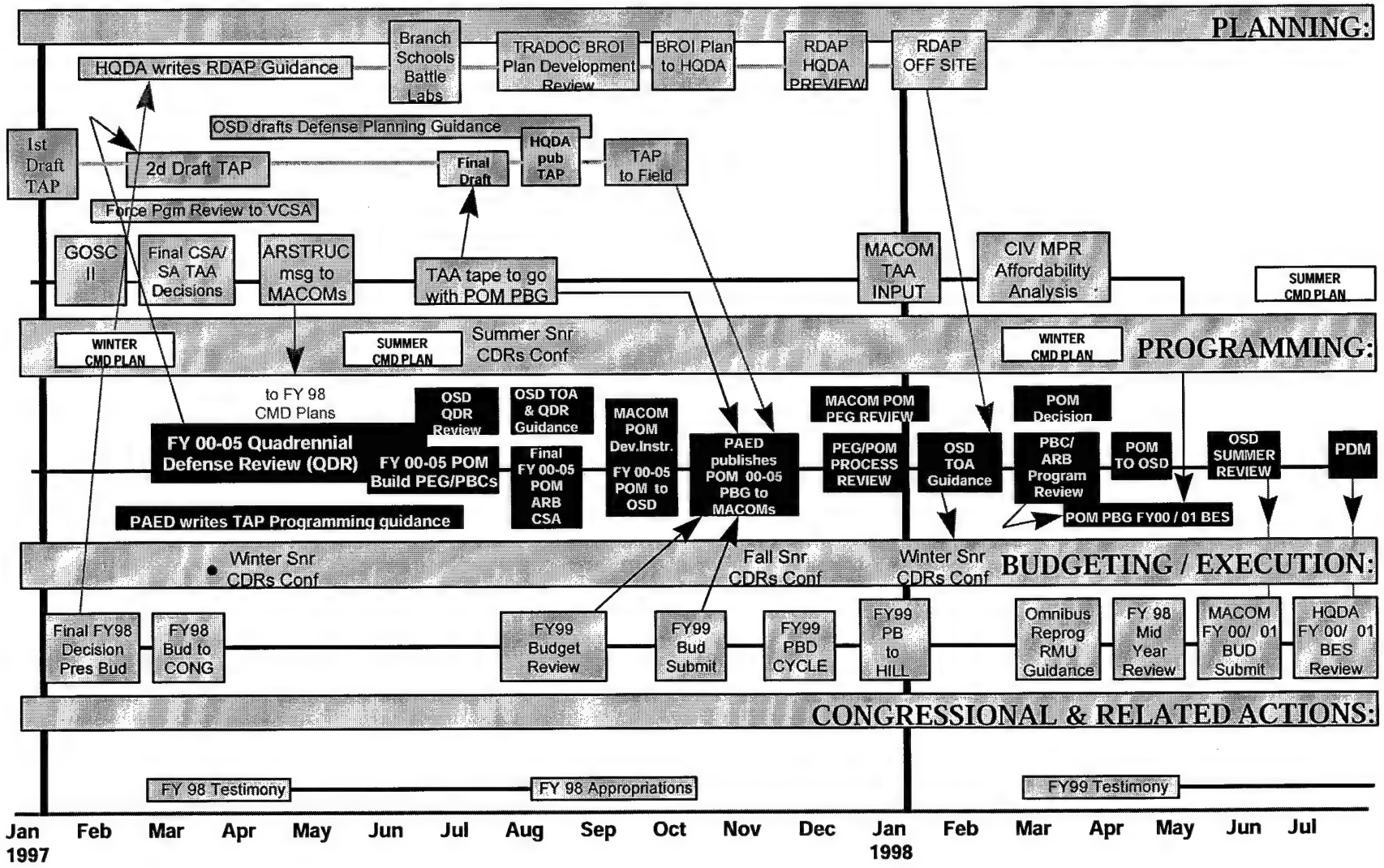


Figure 2-5. POM 00 - 05 Time Line

(b) Army Program Guidance (APG). The APG guides program development. HQDA issues a draft of the document as part of the draft TAP in January of the even-numbered year. It issues a final version the following June, also included as part of the TAP.

(c) Program administrative instructions

1) MACOM POM Development Instructions (MPDI). The MPDI appears in May of the odd-numbered year. The document gives administrative instructions to guide MACOMs and PEOs in preparing their program submissions and to the MACOMs for submitting CINC high-priority war-fighting needs.

2) Army POM Preparation Instructions Supplement (APPIS). The APPIS appears in January of the even-numbered year. For HQDA staff agencies, the document augments OSD's POM Preparation Instructions (PPI).

(d) The Program and Budget Guidance (PBG) is the document that provides resource guidance to MACOMs, PEOs and other operating agencies. The PBG is published three times each year, consistent with the FYDP updates associated with the development of the Army POM (May PBG), the submission of the Army BES (Fall PBG) and the President's Budget submission (Feb PBG).

(e) Usually, HQDA completes the program and prepares the POM in March. The document's narrative and supporting exhibits reflect program actions fleshed out by the HQDA staff with the Directorate of Program Analysis and Evaluation (DPAE). It also documents the program decision of the SA and CSA. Sent to OSD in April/May, the POM submits the Army program for OSD review.

(f) Within 45 days after the Services submit their POMs, the Joint Staff issues the CPA. Assessing the balance and capabilities of the POM force and reporting on the adequacy of Service support levels to attain U.S. national security objectives, the CPA helps OSD evaluate program issues. Having started in early April, the OSD program review continues until mid- to late June. At that time and when the Defense Planning and Resources Board (DPRB) has debated all outstanding issues, the DEPSECDEF signs the PDM. The PDM approves the POM with specific changes as the program basis for Army budget estimates submitted to OSD.

(3) Budgeting process and major documents

(a) Army budgeting proceeds in three stages: formulation, justification, and execution. Budget formulation converts the first 2 years of the program, as approved by the DEPSECDEF in the PDM, into the Army budget estimates. Budget justification presents the estimates to Congress and defends them before that body. Budget execution applies congressionally approved resources consisting of the authorized manpower and appropriated funds to accomplish the approved program.

(b) OSD-OMB budget review. Members of OSD and OMB jointly review Army budget estimates. The joint review focuses on fine-tuning the BES, in development of the DoD budget input for the President's. Budget. The review typically starts with a series of briefings to OSD and OMB representatives that will serve as a baseline for the decisions OSD will present to the Army leadership through the Program Budget Decisions (PBDs).

(c) President's budget. In mid-December at the end of the PBD cycle, OSD issues a final PBD incorporating any changes resulting from Major Budget Issue (MBI) deliberations. Completing the review phase, the Office of the Secretary of Defense-Office of Management and Budget (OSD-OMB) and the Military Departments submit required budget information in the form of the President's budget. The budget provides updated resource estimates for the prior and current years. It also covers estimates of TOA for seven years with focus on the budget year and budget year plus 1. The ABO updates the FYDP to reflect the President's budget submission. (As mentioned, a 1987 statutory change [Title 10 United States Code Section 114] requires DoD to annually submit to Congress the FYDP coinciding with the President's budget.) Managers for Program and

Performance and Appropriation Sponsors update their internal systems and the PROBE data base to reflect adjustments resulting from budget review and approval.

(d) Budget hearings

1) During budget justification, the Army presents and defends its portion of the President's program before Congress. The process proceeds under the staff supervision of the Assistant Secretary of the Army (Financial Management and Comptroller) (ASA(FM&C)).

2) After the President formally submits the budget, the Army provides detailed budget justification material to the authorizing and appropriations committees. First, however, Appropriation Sponsors will have prepared the justification material to conform with decisions of the SECDEF and the President. The justification material also must conform to congressional requirements for specific formats and supporting information. Justification books undergo internal Army review under OASA(FM&C) supervision before being sent to OSD for final review.

3) The authorization and appropriation committees hold hearings to discuss the issues in the budget request. The SA and the CSA normally testify first. The OASA(FM&C) and Office, Chief of Legislative Liaison help program managers in presenting and defending the details of the budget.

(4) Budget execution applies the funds appropriated by Congress to carry out approved programs. The procedure entails:

(a) Apportioning, allocating, and allotting funds.

(b) Obligating and disbursing funds.

(c) Reporting and reviewing.

(d) Financing unbudgeted requirements. Unbudgeted requirements are caused by changed conditions unforeseen at the time of the budget submission. Also, they are requirements that have a higher priority than those from which funds were diverted.

(5) An apportionment distributes funds by making specified amounts available for obligation. The Army requests apportionment from OMB by submitting justification through the DAB, ASA(FM&C) and OSD at the time of budget review. OMB approves the requests, returning apportionments through OSD. Operating agencies, in turn, make funds available to subordinate commands and installations by an allotment. Allotments authorize users to place orders and award contracts for products and services to carry out approved programs. Installations obligate funds as orders are placed and contracts awarded. They make payments as materiel is delivered or as services are performed.

(6) Congress recognizes the need for flexibility during budget execution to accommodate unforeseen requirements or changes in operating conditions. Congress accepts that rigid adherence to program purposes and amounts originally budgeted and approved would jeopardize businesslike performance. Accordingly, as controlled by stated restrictions and within specified dollar thresholds, Congress allows Federal agencies to reprogram existing funds to finance unbudgeted requirements. MACOMs, PEOs, and other operating agencies carry out the approved program within manpower and funds provided. They review budget execution, and account for and report on the use of assigned manpower and funds by appropriation. The manpower and financial data received as feedback help MACOMs and agencies develop future requirements.

(7) HQDA conducts a Quarterly Army Performance Review, which is a management review of selected Army programs.

e. Key cost analysis interfaces

The function of the POE and CCA is to provide an assessment of life cycle costs to the decision maker during the acquisition process. During the planning process, the POE will provide a credible source for the early planning estimates or "budget wedges." During the programming phase, the cost estimate most readily supports the analysis of "what if" drills. Because of the nature of cost estimates, they provide an excellent basis from which to assess the impact of changes in the program. Up to this point in the process, the key question is "What will this change cost?" During the budgeting phase, the cost estimate plays an important role, but the nature of the question often changes. During this phase, the question is more often, "What will this level of funding do to the program plan?" The level of detail in the cost estimate grows as the system progresses through the acquisition process. Therefore, the POE and CCA offer excellent tools to answer these questions and support the decision process in the PPBES. The nature (the inclusion/exclusion criteria) of the MDEP changes for each Army program to meet the specific needs of the PPBES community. Therefore, cost analysts must check the structure of their cost analysis results to ensure they are in line with the current budget guidance. If they are not, an excursion to the estimate should be prepared that is in line with the budget guidance. The POE and CCA are ready tools to support planning, programming, budgeting, and execution analyses during each phase of the process described in the previous sections. However, the cost estimate does not play a direct role in the execution process. This phase is the tracking of the execution of the budget decisions made during the budgeting process. The data received during the execution phase provide critical feedback on the accuracy and timeliness of the cost estimate. Therefore, this phase of the PPBES process provides critical feedback to the cost analyst.

2- 4. Interrelationship with the contract process

a. Introduction

Cost analysis plays a critical role in the evaluation of contractor proposals and the monitoring of contractor progress (contract cost and schedule). The following sections describe the cost analysis interfaces with the contract cost/price analysis, reconciliation of proposed contract award price, and contractor cost data.

b. Contract cost/price analysis

(1) Title 10 United States Code Section 2306a (10 USC 2306a)(Cost or pricing data: truth in negotiations) requires prospective prime contractors and their subcontractors to submit certified cost or pricing data in support of their proposals. Contractors must submit cost or pricing data on all procurements other than sealed-bid of more than $100,000. They must submit cost data in the SF 1411 format (formerly DD Form 633). This format requires the contractor to separate the proposal and supporting data into the following groups:

(a) Purchased parts.
(b) Subcontracted items.
(c) Raw material.
(d) Engineering labor.
(e) Engineering overhead.
(f) Manufacturing labor.
(g) Manufacturing overhead.
(h) Other general and administrative (G&A).
(i) Profit.

(2) When submitting certified cost or pricing data, contractors use a Certificate of Current Cost or Pricing Data stating the data are accurate, complete, and current as of the final agreement date. The contracting officer shall make a cost analysis to check the reasonableness of individual cost elements. In addition, the contracting officer shall make a price analysis to ensure that the overall price offered is fair and reasonable. A comparison of the negotiated price to the program cost estimate fulfills the price analysis requirement.

(3) Contract cost analysis is the traditional method for analyzing a contractor's proposal. It is the analysis of the separate cost elements and profit of (1) an offeror's cost and pricing data and (2) the judgmental factors applied in projecting from the data to the estimated costs. The analyst does this to form an opinion on the degree to which the proposed costs represent what the contract should cost. This review includes a technical appraisal of estimated labor, materials, tooling, scrap, etc., and the application of audited or negotiated indirect and direct rates. Also, the analyst must consider past and current actual costs in projecting estimates of cost to perform a scope of work. In some commands, this work is done by a price analyst. In recent years, contractors have been able to use parametric cost estimating techniques. See section 3-3.c. Cost-estimating methods section on parametric cost estimating methods.

(4) These reviews are a contracting officer team effort. The contracting officer will usually request the evaluation from experts within and outside the buying organization. Individuals within the procurement organizations will review material costs, engineering and manufacturing hours, testing, tooling, etc. They may request field pricing support from the Defense Contract Audit Agency (DCAA). The contracting officer starts these review efforts. The contracting officer uses the data generated by these reviews in the development of the Government's negotiation position and overall negotiation strategy.

(5) Should Cost analyses go beyond the traditional contract cost analysis concept, by the use special teams of highly qualified individuals to perform a rigorous, in-depth analysis of all phases of a contractor's operation. The team's purpose is to perform a one-time task and disband after completion of that task. The goal is to identify uneconomical or inefficient practices in a contractor's management and operation and to quantify the cost impact of those findings. Should Cost procedures require a review only on sole-source major programs (that is, a $100 million or more annual production contract). The reviews address only the first production contract (when setting up the production line) and the procurement after completion of the first production lot.

(6) The difference between traditional contract cost analysis and a Should Cost study is the analysis' depth and the extent to which analysts challenge inefficiencies. The Should Cost team will explore such areas as materials, subcontracts, operations, labor, overheads, estimating procedures, material handling, make-or-buy, etc. Some of the analyses may not apply to the specific proposal under review, but they may be helpful in the long term, since long-term production tooling improvements may reduce the future cost of an item. Normally, a negotiation ceiling price results from the Should Cost study.

(7) The exchange of cost data between the program cost and contracting processes is very important. For initial production contracts, the negotiation goals are set to create a directly traceable basis from the program cost estimate to the negotiated price. This is accomplished by predetermining exactly how the negotiated goals will track to the program contract cost estimate before getting a business clearance. By having IPRs between Should Cost study team members and program management personnel, traceability is maintained during the Should Cost study. Comparison between the Should Cost team recommendations and the contract estimates shows the reasonableness and affordability of contractor proposals. A planning Procurement Work Directive (PWD) for each Contract Line Item Number (CLIN) of the RFP is submitted before issuance of future-production Request for Proposals (RFP). The PWD is based on estimates from the current program cost estimate. This is done to ensure that the CLINs or groups of CLINs are directly relatable to the cost and work breakdown structure (WBS) elements of the program cost estimate. Theses direct relationships between CLINs and the POE aid in updating the estimate based on the actual negotiated price. Incorporating the results of the latest negotiated price in the program cost estimate is an iterative process. The result is used during future proposal evaluations and negotiations.

c. Reconciliation of proposed contract award price

(1) Army Defense Acquisition Regulation Supplement (ADARS) 3-802 requires that the contracting officer get an independent cost estimate during the presolicitation process, in preparation for the contract estimate evaluation and award. An independent party prepares the presolicitation contract cost estimate (or independent Government Cost Estimate) separate from the influence of data provided in a contractor's production proposal. For production contracts for major systems, Army decision makers will use this estimate at Milestone III and later procurements.

(2) Project Managers for major systems must advise contracting officers of the estimated cost for each contract from the POE. Prior to the contract award, the contracting officer must reconcile the presolicitation cost estimate and the proposed contract award price. The cost analyst will be a great asset to the contracting officer during the reconciliation. This reconciliation shall be compatible with the WBS and cost element structure of the POE. The results of this reconciliation will be used to update the POE.

(3) The contract portion of the POE reflects the presolicitation cost estimate. Cost analysts are responsible for producing a POE in enough detail that it can be used as a presolicitation estimate. Contracting officers must identify their requirements during the formulation stages of the program cost estimate. Also, they should participate in the development of the cost estimates, lending their business and contractual judgment to the cost estimating process. Finally, they must aid, coordinate, and accept the contract portion of the program cost estimate as their benchmark for contract price comparison.

d. Contractor cost data

(1) The Cost Performance Report (CPR) and the Contract Funds Status Report (CFSR) are two contractor cost data reports that analysts can use to monitor contractor performance and to update the program cost estimate. CPRs apply to most major contracts (contracts exceeding $60 million RDT&E or $250 million production in FY 90 dollars). Cost/Schedule Status Reports (C/SSRs) similarly apply to most non-major contracts. DoD 5000.2-R does not require compliance with the Cost/Schedule Control System Criteria on firm fixed price (FFP), time and materials (T&M), and contracts that consist mostly of level-of-effort work, although the milestone decision authority may make exceptions. The monthly CPR provides work scheduled, work performed, actual cost of the work performed, and the contractor's estimate of the actual cost at completion. The quarterly CFSR provides time-phased funding requirements and execution and identifies requirements for agreed-to work not yet under contract.

(2) The CPR and CFSR reports provide another source of data for the POE and CCA. The CPR data show the contractor's cost and schedule performance trends and allow the program manager to independently assess the contract cost at completion. These data are extremely useful to the cost analyst in estimating the cost of future work. The CPR variance analysis can give indications of potential cost overruns. Also, it may provide insight into contract and technical execution that could influence the cost estimate. The CFSR data can ensure that the Government's funding plan is consistent with contractor performance trends.

(3) The Contractor Cost Data Reporting (CCDR) system is a primary data base used in DoD cost estimating. DoD has established uniform procedures for collecting contractor costs for ACAT I and II programs and designated the OSD Cost Analysis Improvement Group (CAIG) as the CCDR proponent for reporting. CEAC is the Army focal point for CCDR implementation. In the CCDR plan, the PM tailors cost data collection to satisfy program and DoD requirements. The plan identifies the reportable WBS elements, the type of reports required (CPR, C/SSR, CFSR, or CCDR), and reporting frequency. The PM submits the draft CCDR plan to CEAC for review (ACAT I systems) or approval (ACAT II systems). The CAIG approves CCDR plans for ACAT I systems. The CCDR requirement includes four reports: Cost Data Summary Report, Functional Cost-Hour Report, Progress Curve Report, and the Plant-Wide Report level. These reports provide actual lot-based costs at a level of detail required to develop credible cost-estimating relationships, such as hours and dollars by type of labor, material, and subcontract costs.

e. Key cost analysis interfaces

(1) Cost analysis supports contracting efforts by initially estimating and developing a rationale for the resources needed to fund the requirement. For major contracts, cost estimates support the Government's negotiation team. Cost analysts are frequently members of Source Selection Evaluation Boards and other special teams to support contracting efforts. The CCDR plan guides the development of a common WBS for both the cost estimate and the contract. Cost analysts can also support contract execution through the analysis of contract cost performance reports.

(2) A contractor's current and future financial condition has a significant impact on its ability to successfully execute the terms of a contract. A careful analysis of a firm's financial health through ratio, cash flow, and other financial analyses enables the Army to make informed decisions during the source selection process, negotiate with potential contractors concerning the amount of money to be paid and how payment is to be made, and monitor contractor performance after contract award. The Army must be assured that firms can meet contractual obligations in terms of costs, schedule, and performance.

(3) Contractors now are able to use parametrics to estimate their responses to Request for Proposals (RFPs). Since the Army Acquisition Executive and the Assistant Secretary of the Army (Financial Management & Comptroller) endorsed the Automated Cost Estimating Integrated Tools (ACEIT) model and since it is widely used to prepare POEs, CCAs and ICEs, it would expedite the comparative analysis of the submission if the contractor uses the same model.

CHAPTER 3 - COST ANALYSIS PROCESS, METHODS, AND TECHNIQUES

3- 1. Introduction

This chapter provides an overview of the cost analysis process, including methods and techniques. The primary purpose of cost analysis is to translate resource requirements (equipment and personnel) associated with programs, projects, or processes into dollar values. Analysts use these cost estimates to translate resource requirements into budget requirements.

3- 2. The analytical approach

a. An analytically sound methodology and a systematic approach are the keys to developing reliable and valid cost analyses. The following six steps briefly describe the general cost analysis approach:

(1) **Set up definitions, ground rules, and assumptions/constraints**. At the beginning of each cost analysis, the analyst must determine the scope of the problem or issue. This definition, with the ground rules and assumptions, provides the basis for the cost analysis. For major materiel systems, the DoD Component responsible for the system's development must prepare a Cost Analysis Requirements Description (CARD). Chapter 4 and appendix I discuss the CARD in more detail.

(2) **Select the cost structure**. A well developed cost structure ensures that a program is completely costed and eliminates double counting. For materiel systems, there are two types of structure. The first is the cost element structure (CES). This structure groups costs into system-specific and appropriation-discrete cost elements. The second is the WBS. MIL-STD-881B, which will be updated by Military Handbook 881 (MIL-HDBK-881), defines the general WBS elements, by commodity. Since elements will vary slightly among materiel systems, each materiel system will have its own WBS. Combining the WBS with the CES forms a structure that provides the primary means for ensuring the consideration of all appropriate costs. Chapter 4 and appendices D and E provide a set of well-defined cost elements, a structure, and formats to document and present a materiel system cost estimate.

(3) **Compile the data base.** The process of identifying appropriate data sources is a critical step towards completing a successful analysis. Data in the form of cost, technical, and programmatic information serve as the basis for the analysis. Data take many forms, such as historical contractor cost reports, Government contracts, cost/technical data bases, data from previous estimates, and Should Cost studies. Selecting appropriate data for the task requires sound analytic judgment, because the analysis process benefits from organized and structured data. The analyst must analyze historical data to verify comparability between the current program and previous or similar programs. Also, the analyst should identify and address any anomalies in the data and adjust it for inflationary effects and quantity differences, as necessary.

(4) **Prepare the cost estimate.** In the preparation of a specific estimate, the analyst may use more than one cost-estimating technique. For example, if a conceptual system involves key equipment for which there has been no experience, a detailed engineering cost estimate would not be possible, since the system description is minimal and historical data does not exist on key areas. Therefore, analogy cost estimates would be used when historical cost data exist for one or more items that are similar to those proposed. Parametric cost estimates would be appropriate when relationships between cost and system characteristics can be authenticated.

(5) **Test the total cost estimate.** The purpose of testing the estimate is to ensure reasonableness and completeness. The analyst should test key cost elements for sensitivity to the cost-estimating techniques used and to key ground rules and assumptions. Finally, the analyst should conduct a cost-risk assessment.

(6) **Prepare documentation.** The analyst must document all steps in the development of a cost estimate, including definition, ground rules, and assumptions. Also, the analyst must state the source of all data and the processes used to analyze the data. In addition to the identification of the methods employed for each cost element, the documentation should address the rationale for that selection. The documentation must provide enough detail for another person to track the cost-estimating process from definition to conclusion and to modify the analysis at a later date. Chapter 4 provides cost documentation standards for materiel systems.

b. Figure 3-1 depicts the general methodology.

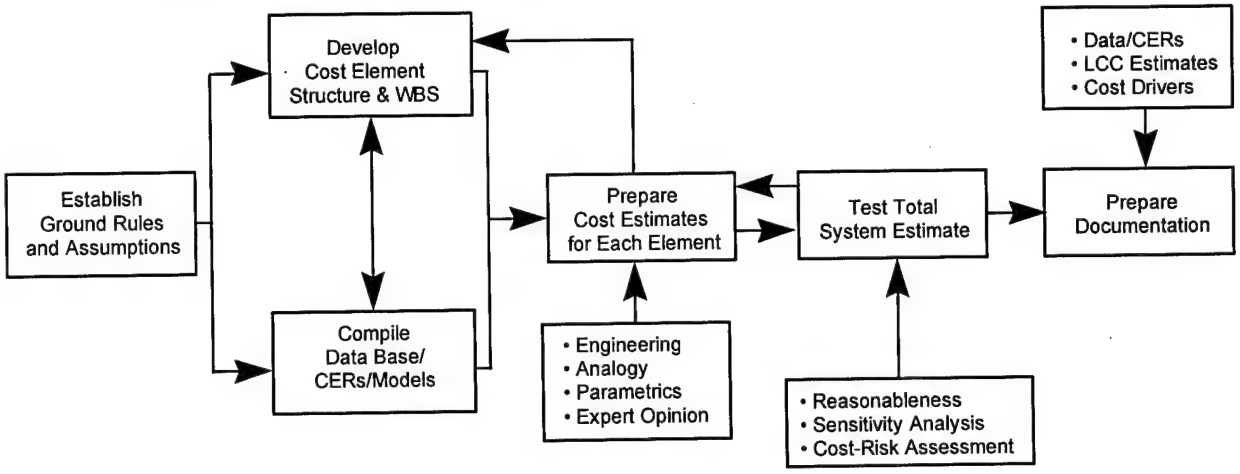


Figure 3-1. Cost Analysis Methodology

3- 3. Cost-estimating methods

a. The engineering approach, parametric approach, analogy approach, and expert opinion approach are four cost-estimating methods. The use of a specific approach varies with the reliability and quantity of available data. Each approach has limitations.

b. The engineering (bottom-up) approach is an examination of separate work segments in detail and a synthesis of the many detailed estimates into a total. With this approach, the analyst divides the system, activity, or item of hardware into its segments and makes an estimate of each segment's costs. The analyst then combines these estimated costs with estimates of integration costs to arrive at a total cost. A major limitation of the engineering approach is that it requires the analyst to have an extensive knowledge of the system, activity, or item. Also, the analyst must know both the development and production processes. Particularly for new technologies, the detailed knowledge required for a complete engineering analysis is not always available, making this approach the most difficult to apply.

c. In the parametric approach, the analyst relates cost to some physical attributes or performance characteristics. An attribute can be weight, horsepower, bore diameter, fuel consumption, etc. In developing the cost-estimating relationship (CER), data availability limits the application. Confidence in the results of a parametric estimate depends directly on setting up valid relationships between cost and definable physical attributes or performance characteristics. When documenting the results of a parametric approach, the analyst must present the statistical characteristics, data sources, and assumptions surrounding its development.

d. The analogy approach is a direct comparison with historical data of similar existing systems, activities, or items. The major limitation of this approach is that it is a judgment process and requires considerable

experience. The analyst must show the validity of the direct comparison. A variation to this methodology is to adjust the historical data to account for some variation in the proposed system, activity, or item. For example, if commercial vehicle data are used to estimate some aspect of a tactical vehicle, then the historical data might have to be adjusted to accommodate the impact of complexity or "militarization." It is very important that the analyst document the "adjustment technology" to show the applicability of the methodology.

e. The expert opinion approach uses the subjective judgment of an experienced individual or group. Whenever expert opinion is used, the documentation should contain the sources of the opinions cited. Also, the documentation should include a list of the sources' attributes that make them experts. It is very important to show the credibility of the experts.

(1) One common technique used is the Delphi questionnaire. This technique involves querying a group of experts about their opinions. The analyst seeks information and supporting rationale independently from each expert. Then the analyst summarizes the results and sends a report to each expert. The analyst gathers a second opinion from each expert, summarizes those results, and reports again to the experts. This iterative process continues until the experts reach a consensus, or near-consensus.

(2) A second application of expert opinion in cost analysis is the development of cost knowledge bases. Both knowledge bases and traditional data bases store information, but differ significantly in the type of information stored. Data bases store only facts. In addition to the facts, knowledge bases capture, cause-and-effect relationships, estimating rules such as time-tested rules of thumb, and probabilistic information. Expert opinion is used to develop knowledge bases. In cost estimating, knowledge bases have the potential of improving the applicability and utility of existing data bases.

3- 4. Estimates in constant, current, and discounted dollars

a. Estimates prepared in constant dollars do not show the changing spending power of the dollar over time. When estimates are used for programming and budgeting, they must be adjusted for inflation. OMB is responsible for developing inflation guidance by appropriation for Government estimates, Normally each January, OSD distributes this inflation guidance to the Services. This coincides with preparations for the budget and the annual Selected Acquisition Report (SAR). It is important to use the latest inflation guidance for all estimates.

(1) Constant-year dollars must be associated with a base year (for example, FY 96 constant dollars). To be in constant dollars, the analyst must adjust the costs so they reflect base-year prices for all time periods. Constant dollar estimates help the analyst determine the true cost changes of a system, activity, or item. Normally, estimates should be prepared in constant dollars for the year after the calendar year in which the estimate will be completed.

(2) Current-year dollars (then-year dollars) reflect the effect of inflation. That is, they reflect the buying power of the dollar in the year the work was done or programmed. Prior costs are the actual amounts obligated or spent. Future costs stated in current-year dollars are the amounts that should be programmed under the full funding concept. When making cost estimates, the analyst changes the constant-dollar estimate to a current-year dollar estimate by applying the correct inflation factors. These factors not only adjust for the year-to-year compound inflation rates, but also include appropriation-unique outlay rates. For example, the RDT&E appropriation historically expends 51.3 percent in the first year, 36.7 percent in the second, 8 percent in the third, and 4 percent in the fourth year. Thus, the analyst calculates the current-year dollar value for year 1 by using an inflation factor that assumes the funds will be spent (outlay) over 4 years. The factor incorporates the expected outlay rate with compounded inflation rate. As a result, where there are significant outlays, the constant-dollar and current-dollar costs for even the base year will differ.

b. The time value of money considers the value of money at different points in time. Interest costs, the Government's cost of capital, vary by time period, expenditures , and alternative acquisition strategy. Future expenditures must be adjusted to a common point in time for comparison. This adjustment is called discounting, a technique used for converting cash flows occurring over time to equivalent value at a single point in time.

(1) OMB Circular A-94 and DoDI 7041.3 require the use of a discount rate based on the Treasury Department cost of borrowing funds. This discount rate should be used in evaluating the measurable costs and benefits of programs or projects when they are distributed over time. The prescribed rate will vary dependent on the length of the period of analysis and on whether the costs and benefits are measured in constant or current dollars. A discount rate that has already been adjusted to eliminate the effect of expected inflation should be used to discount costs and benefits expressed in constant dollars. Conversely, a discount rate that reflects expected inflation should be used to discount costs and benefits expressed in current dollars.

(2) The estimate of the discount rate is prepared annually by the OMB, and reflects the expected cost of borrowing for 3, 5, 7, 10, and 30 year securities. Annual updates to discount rates are provided by OMB in the February/March time frame, and are disseminated throughout the Army by CEAC upon receipt.

(3) Documentation must specify whether end-of-year or mid-year values are used. The use of mid-year values is preferred, because this reflects the normal situation where expenditures are spread throughout the year. If end-of-year is used, include justification in the documentation as to why end-of-year values were used rather than mid-year values.

(4) For additional information on discounting, see the Department of Army Economic Analysis Manual.

c. A cash flow diagram is useful for displaying and understanding payments of money over time. This type of diagram graphically displays the timing and size of all costs and benefits associated with a given estimate. Figure 3-2 is an example of a cash flow diagram for an alternative with a 9-year life. In this cash flow diagram, a downward arrow depicts costs while an upward arrow shows benefits. This alternative has an investment of $500 at the beginning of year 1, midyear annual costs of $30, one-time costs (midyear) in years 4 and 8 of $50, midyear benefits of $60 in year 2 and $120 annually in years 3-9, and a salvage value of $20.

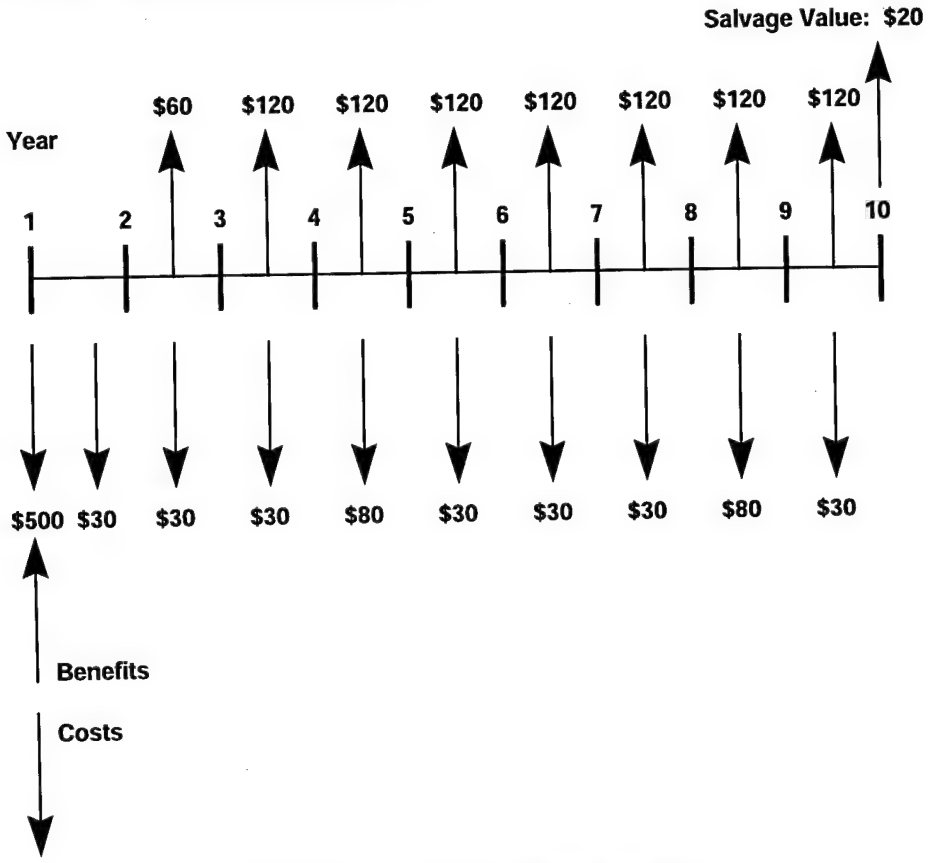


Figure 3-2. Cash Flow Diagram

3- 5. Cost-estimating data sources

a. A cost analyst should identify, collect, classify, and analyze data before doing cost estimating within the analysis process. Cost data, by definition, include all available quantitative and monetary information. Potential data sources are listed below. This list is not all inclusive. Regardless of the nature of the data used, the source must be identified in the documentation of any analysis. The cost analyst should be aware of the sensitivity of contractor proprietary data.

(1) Financial reports.
(2) Budget and Program Objective Memorandum (POM) submissions.
(3) Management Decision Packages (MDEPs).
(4) Contract cost and performance reports.
(5) Audit reports.
(6) Manpower records/reports.
(7) Statistical reports.
(8) Surveys.
(9) Management studies.
(10) Modernization plans.
(11) Industry guides and standards.
(12) Professional journals and publications.
(13) State and local government publications.

(14) Army publications.
(a) Field manuals.
(b) Standard operating procedures.
(c) Table of organization and equipment/table of distributions and allowances (TOE/TDA) documentation.
(d) MANPRINT documentation.
(e) Regulations.
(f) Pamphlets.
(g) Official policy guidance.
(h) Cost Analysis Requirements Description (CARD).
(15) DoD directives, instructions, and manuals.
(16) Technical manuals.
(17) Other Federal agencies, to include the OSD, Air Force, Navy, Marine Corps, and Coast Guard.

b. Cost estimating requires a relational comparison among data. A basic premise underlying the application of analytical review procedures is that relationships among data exist and will continue unless conditions change. The presence of these relationships provides the analyst with indicators that can form the basis for assumptions, cost factors, and CERs.

c. Cost-estimating relationships use various combinations of data, such as dollars, physical characteristics, quantities, ratios, or percentages. The CER should be relevant, valid, verifiable, and reasonable.

d. After identifying and collecting cost data, the analyst must relate the data to cost elements. Cost elements are the lowest level of a cost estimate. The cost estimate total is the sum of all the cost elements.

3- 6. Software cost estimating

a. Because software life cycle costs account for a significant portion of information systems' costs, and are often significant in materiel systems, they must be estimated carefully. Software cost estimating involves a large degree of professional judgment, from both a project management and cost analysis perspective.

b. The typical software life cycle phases are plans and requirements, product design, detailed design, code and unit test, integration, implementation, operations and maintenance, and phaseout. The most critical of all the phases is the plans and requirements phase. A thorough analysis of the software development requirements during this phase will avoid many future changes that lead to schedule slippages and cost overruns.

c. One way to develop software cost estimates is by collecting historical data on processes similar to the one being modeled (analogy). The data is used to form an empirical relationship between the required tasks and the resources needed to complete them. There are several software cost models available to estimate software development costs, but no one model is superior for all applications. The use of these models requires a high level of professional judgment and their accuracy is, in part, a function of how closely the historical data correlate to the modeled process. Regardless of the model used to estimate software costs, the results will not be better than the input data.

d. Most models use estimated lines of code (LOC) to estimate software development costs. The sizing of the development effort directly relates to the program requirements determined during the plans and requirements phase. Various models and techniques are available to aid the analyst in sizing the proposed program. Sizing by analogy, function point analysis models, and size-in size-out are just a few of the techniques used for sizing software development efforts.

e. It is important to estimate LOC as closely as possible, since that number drives the estimate of the project cost and completion schedule. It is also important to identify reusable software LOC. Software development, writing, and installation incur high costs. Cost reductions are possible using reusable code, code generators, and object-oriented programming, because they reduce the number of LOC that must be written, thus reducing the cost to develop the software.

3- 7. Cost as an Independent Variable (CAIV)

a. Overview

(1) DoDD 5000.1 recognizes the fiscal constraints on the defense acquisition process. Cost as an Independent Variable (CAIV) is one tool to meet our objective of acquiring systems that are both operationally effective and affordable throughout their life cycles. At major milestone reviews, the Milestone Decision Authority approves aggressive, achievable life cycle CAIV objectives and approves the management plan to achieve these goals. These objectives become part of the Acquisition Program Baseline.

(2) The acquisition strategy addresses the means to meet the CAIV objectives -- balancing mission needs with available resources. Normally, at the inception of an acquisition program (Milestone I), the Program Manager (PM) with the collaboration of the user proposes system thresholds and CAIV objectives for cost, schedule and performance that will result in a product that is both operationally suitable and effective -- and timely and affordable. CAIV is not limited to new programs. It is also implemented when there are major modification to existing programs.

(3) Proposed system thresholds establish the requirement boundaries separating an acceptable from an unacceptable product. Examples of system thresholds are limits for unit cost, weight, or power consumption which, if exceeded, would require the reevaluation of either the concept design, its acquisition approach, or the system requirement.

(4) The successful application of CAIV requires continuous, effective communications between the acquisition community and the operational user. The developer must master a full understanding of user needs. The user, in turn, benefits from close engagement with the developer --tracking program progress and gaining insights into the product's future operational potential and limitations. This collaboration is needed to achieve the proper balance among the product design dimensions of cost, schedule and performance.

(5) In the Army, Integrated Concept Teams (ICTs) and Integrated Product Teams (IPTs) are important forums for continual, open communications between the stakeholders. Before milestone 0, the user led ICTs include the developer in investigating the feasibility of a wide range of proposed concepts that provide a materiel solution to the identified operational need. The AOA is the mechanism that links the proposed concept to the mission capability. "Order of magnitude" life cycle cost is one important selection attribute used during the AOA.

(6) The application of CAIV challenges the user to identify a limited number of Key Performance Parameter (KPPs), which establish non-negotiable limits for system performance, from among all of the desired performance parameters. KPPs are selected based on their relatively high contribution to the system's overall operational performance. For example, one set of KPPs might include a day/night operational capability and effective range, transportability, lethality, and survivability limits. KPPs must not be allowed to be so numerous or restrictive that they make meaningful cost, schedule, and performance trade-offs impossible.

(7) The user community drafts the Mission Needs Statement(MNS) with the support of the materiel developer. For the CAIV process to be most effective, the MNS should not be written to specify a unique materiel solution. As the design concept matures, the PM, with the concurrence of the stakeholders, may

refine the CAIV objectives and the performance thresholds consistent with the user's operational requirements. When necessary, the Mission Needs Statement will be modified to reflect these changes.

(8) As the program moves beyond Milestone 0, the user led ICT transforms into a developer led IPT, continuing the active collaboration between the developer and user. (The same stakeholders are represented in both ICT and IPT.) In the IPT, the user evaluates the potential mission consequences of design trade-offs that impact non-critical performance parameters. A successful CAIV process requires the user's active participation throughout the acquisition cycle.

b. The Cost Analysts Role in CAIV

(1) The Army cost analyst plays an active role in the implementation of CAIV. Army cost analysis is represented on all program ICTs and IPTs. At the pre-milestone 0 concept stage, the cost analyst provides "order-of-magnitude" estimates of the cost to bring emerging technologies from the technology base to full scale development. They also estimate the cost to produce and operate them. At this early stage, it is critically important to ensure that cost assumptions for competing alternatives represent reasonable expert assessments of the expected technical difficulty. These early estimates play an important role in the relative rankings of the AOAs. As alternatives are down-selected, these early "order-of-magnitude" estimates are developed into the basis for initial program planning and budgeting.

(2) Cost analysts establish linkages between the early promises of new technology, the expected mission capability and the resulting life cycle costs.

(3) The ACP is required at milestone decision points for all ACAT I and special interest ACAT II programs. The ACP is the approved life cycle cost estimate for the program described in the Cost Analysis Requirements Description (CARD). The draft ACP is developed in the Cost IPT, which is co-chaired by the PM and the US Army Cost and Economic Analysis Center. The Cost Review Board, composed of senior Army functional leaders, reviews the draft ACP and advises the Assistant Secretary of the Army (Financial Management and Comptroller) (ASA(FM&C)) on its reasonableness. When approved by the ASA(FM&C), the ACP is the basis for decision making, contracting, programming, planning and budgeting. The ACP is the cost to achieve the threshold system requirements, or a reasonable tasking from the threshold system as reflected in the CARD.

(4) CAIV objectives are related to the ACP. Depending on the program phase, the Cost Performance IPT (CPIPT) group (which looks a lot like the Cost IPT) works from either the ACP developed information ,or earlier "order of magnitude estimates" to investigate the relationships between technology/cost/schedule and mission effectiveness. These analyses assess the related technical, cost and schedule risks associated with a particular course of action. These analyses support the PM's development of aggressive CAIV objectives to propose to the Milestone Decision Authority at the time of the milestone reviews. When successful, these approaches would be incorporated into subsequent CARDs and ACPs. The CAIV objectives will hopefully reduce the program life cycle resource requirements and be incorporated into the Army budget.

3- 8. Risk and uncertainty analysis

a. Although many people use the terms "risk" and "uncertainty" interchangeably, a distinction can be drawn between them. Risk deals with measurable probabilities, while uncertainty must be defined subjectively. An event contains an element of risk when the likelihood of its occurrence can be defined by a probability distribution. Risk that is defined by a probability distribution is often referred to as "objective risk." The event is uncertain when the likelihood of its occurrence can only be defined in subjective terms. There are many tools and

techniques, such as probability theory, game theory, Monte Carlo technique, Delphi technique, and decision trees to aid in making quantified risk assessments.

b. Risk analysis examines the likelihood that actual results will fall within a specified range around a predicted point estimate, using probability concepts. Once the analysis is complete, the risk must be explicitly defined for the decision maker. Every life cycle cost estimate will have a risk analysis. This analysis is prepared by the Cost Review Board Working Group or the Cost IPT depending on the program.

c. See appendix K provides for additional cost risk analysis guidance.

3- 9. Sensitivity analysis

a. Sensitivity analysis is a tool for assessing the extent to which costs and benefits are sensitive to changes. It repeats a prior analysis using different quantitative values to determine their effects on the results of the basic analysis. If changing an assumed value results in a relatively large change in the outcome of the analysis, it is said to be sensitive to that assumption. And finally, sensitivity analyses provide a range of possible outcomes that are likely cost to provide a better guide for the decision maker than a point estimate.

b. All cost estimates should include sensitivity analyses. The first step is to describe the approach, assumptions, and the model used to conduct the base analysis. Next, identify the factors that warrant sensitivity analysis. Finally, repeat the analysis while systematically changing the values that it is believed to be sensitive to. Some factors that may warrant sensitivity analyses are:

(1) The effects of a shorter or longer economic life.

(2) The effects of variation in the estimated volume, mix, or pattern of workload; for example, the production rate or learning curve.

(3) The effects of potential changes in requirements resulting from either congressional mandate or changes in functional responsibilities.

(4) The effects of potential changes in requirements resulting from changes in organizational responsibility at the site, installation, base, or MACOM level.

(5) The effects of changes in configuration of hardware, software, data communications, prime support equipment, and other facilities.

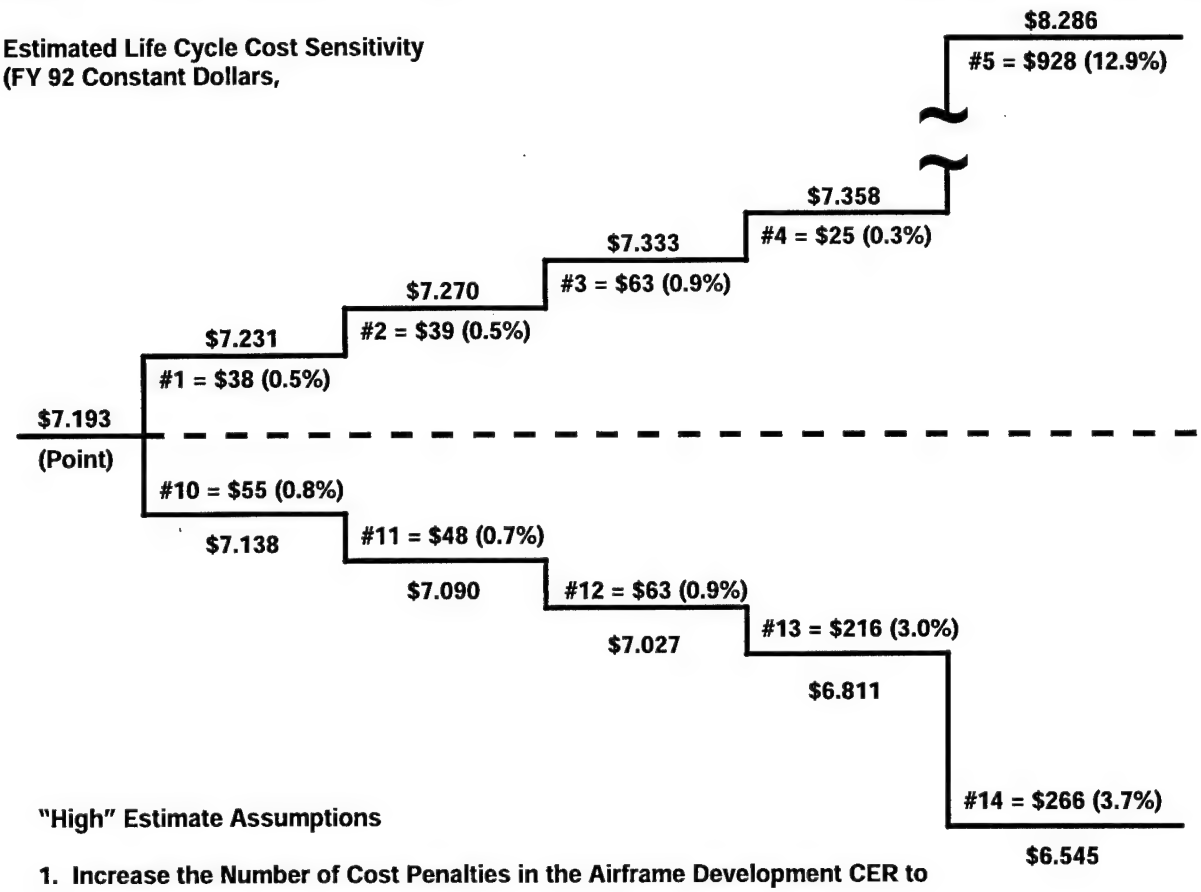
(6) The effects of alternative assumptions on areas such as the project operations, inflation rate, residual value of equipment, and length of development.

(7) The effects of changing the fielding strategy.

c. Figure 3-3, illustrates one way a sensitivity analysis could be presented. Choose the method that best communicates the cost sensitivity information to the decision maker.

3-10. Validation analysis

a. An independent organization or agency should review and validate each cost estimate. The purpose is to verify the existing cost estimate rather than create a new one.



"High" Estimate Assumptions

1. Increase the Number of Cost Penalties in the Airframe Development CER to
2. Double the Development Testing
3. Increase the Airframe Weight to 9,000 lbs.
4. Delay Program "Y" Causing Program "X" to Pay for the First 3,300 Engines off the Production
5. Increase Program "X" Aircraft Quality to Allow for Expanded

"Low" Estimate Assumptions

10. Use an 88% Learning Curve (vs. 91%) for
11. Eliminate Integration and Assembly Cost Add-On Factors for Airframe
12. Reduce Airframe Weight to 8,000 lbs.
13. Improve Aircraft Maintainability and Parts Saving by 15% Due to RAM
14. Reduce Peacetime Flying Hours to 240 Hours per Year (vs.

Figure 3-3. Estimated Life Cycle Cost Sensitivity

b. The review includes a thorough analysis of problem definition, alternatives, assumptions, cost estimate, benefit analysis (as necessary), risks, sensitivity analysis, conclusions, and recommendations. The review of source data and analytical methodology is of particular importance. If time and resources permit, the review should address the applicability of other data sources and methods. Figure 3-4 outlines validation considerations for key elements, methods, and issues.

3-11. Interface with environmental and hazardous material impact analysis

Hazardous materials must be given special consideration during the design phase of the system. Public Law 103-337 requires the Secretary of Defense to analyze the environmental costs of a major defense acquisition as an integral part of the life cycle cost analysis of the program. This analysis should include the materials to be

used, the mode of operations and maintenance, requirements for demilitarization, and methods of disposal. The handling and disposal of hazardous materials have potentially significant cost impacts. The first step is to determine whether the use of alternative materials is possible. Using alternative materials may offset disposal costs by higher design or production costs. Thus, the analyst must evaluate the impacts on costs in a life cycle context. If there is no alternative, reducing the hazardous material handling and disposal impacts can be considered. In addition to health and safety considerations, the requirements for hazardous materials certificates and transportation should be addressed.

- **SYSTEM DEFINITION**
  - Is the system to be costed well defined; CARD or other definition?
  - Are all variances and reasons clearly stated?
  - Are basic study ground rules identified?
- **ASSUMPTIONS/CONSTRAINTS**
  - Are all assumptions clearly stated; not just a repeat of ground rules?
  - Are the assumptions reasonable and can they be validated?
  - Are intuitive judgments identified?
  - Are study constraints identified?
- **INCLUSION/EXCLUSION CRITERIA**
  - Are all cost elements and WBS elements clearly defined?
  - Do the cost elements and WBS elements agree with the system definition and adequately represent the system to be costed?
  - Are all costs included?
- **DATA SOURCE AND DATA ADJUSTMENTS**
  - Are all data sources and data adjustments clearly presented?
- **COST ESTIMATE EXPRESSION AND METHODOLOGY**
  - Does the estimate use good analysis techniques?
  - Is quality analysis presented?
  - Is the estimate arithmetically correct?
  - Are the estimating methodologies identified and are they appropriate for the subject matter?
  - If previous cost estimates exist, can the differences in the current estimate be traced to the previous?
  - Has inflation been applied and calculated properly?
  - Is the source of the inflation indexes identified?
  - Is the estimate documented thoroughly (including assumptions, data sources, methodologies, CERs, results)?
- **SENSITIVITY/UNCERTAINTY**
  - How sensitive are the final results to changes in the values of model parameters?
  - Is uncertainty analysis performed?
- **RESULTS**
  - Are the results clearly presented and do they track to the proposed system PPBES (MDEP) formats?

Figure 3-4. Validation Considerations

3-12. Cost-estimating errors

a. The analyst should always be aware of the four types of cost-estimating errors: double counting, omission of costs, hidden costs, and spillovers.

(1) Double counting occurs when the analyst includes the same element of cost in two portions of the estimate. Thus, the analyst counts the same element of cost twice.

(2) Omission of costs occurs when the analyst overlooks costs that apply to an estimate. Omitting costs can seriously distort the analysis.

(3) Hidden costs can occur in many ways. They can occur from mislabeling cost elements, nondisclosure of certain costs, and improper allocation of overhead.

(4) Spillover costs are secondary effects not directly related to the project/program. For example, when the reference system's requirements require unplanned production of a second system, there are spillover costs. When the analyst does not address these burdens, the decision maker does not know the total impact of the decision.

b. Any of these problems may seriously distort the outcome and reflect unfavorably upon the credibility of the cost analysis.

3-13. Inherited assets

a. Inherited assets occur as systems or organizations phase out of the force. These systems usually release personnel, equipment, or facilities that are available for use by existing or new systems or organizations. When new or existing systems or organizations use these released resources to fill their requirements, they become inherited assets.

b. The availability of inherited assets may make a considerable difference in the cost of a new system. They may be important in cost effectiveness comparisons, especially if one alternative can use inherited assets while the other cannot. A system using inherited assets does not have to fund such one-time costs. However, there may be one-time transitional costs, such as training, transportation, and travel, that the system using the inherited assets must fund.

c. Inherited assets represent an opportunity cost that the analyst must include in the system's estimate that inherits the asset. The rationale for including this opportunity cost is that if a particular project uses the asset, then another project cannot use it. Therefore, the other project will have to purchase a new asset. The Government does not pay for the inherited asset (a second time), but the asset has a value. The analyst must add this value as a cost to the project. However, if only one system needs an inherited asset, then there is no opportunity cost.

d. A practical approach to estimating the value of an inherited asset is to determine its residual value when inherited.

3-14. Residual or salvage value

a. Residual value, or salvage value, is the estimation of future value of assets that will be available later for alternative uses. An example is when a major system phases out of the Army's inventory. Some assets will have value because they can fill requirements of future organizations or can be sold.

b. The analyst should not use residual values to reduce life cycle costs. These costs are sunk by the time residual values come into play. Residual value is a benefit that is very speculative. It does not represent savings, but does represent a potential value. Salvage value is usually negligible.

c. The analyst can estimate residual value using depreciation tables provided by the Internal Revenue Service for different types of assets. Another source is OMB Circular A-76.

CHAPTER 4 - MATERIEL SYSTEMS COST ANALYSIS

4- 1. Introduction

AR 11-18, The Cost and Economic Analysis Program, provides the policies and responsibilities for the conduct of cost analysis throughout the Army. This chapter provides a basic framework of methodologies and procedures for implementing the cost analysis policies in AR 11-18 on materiel systems.

a. Process

(1) Cost analysis is the scientific process used to evaluate the resources required to develop, test, produce, operate, maintain, or cut forces, systems, functions, or equipment. The scientific process of cost analysis requires a thorough understanding of the item and its phases of evolution. Cost analysis includes the identification of assumptions and constraints, collection and testing of data, and application of cost methods, theories, and techniques. Finally, the cost analysis process must include the testing of the results for reasonableness and sensitivity to the assumptions. Analysts usually express the results in dollars. They should include a discussion of the quality of the data, the methods, and the results in their documentation.

(2) Analysts can apply the cost analysis process to either a small portion of a complex system or the total system. An example is the analysis of the cost difference between single-year and multiyear procurement strategies of a materiel subsystem. They can apply cost analysis to the item's total life cycle, or to a single phase of the life cycle. Also, analysts can apply cost analysis to check the relative cost differences between competing alternative solutions.

(3) A cost estimate is the result of the cost analysis of a particular item. Analysts use specific information: a definition of the item, its life cycle phase, assumptions, constraints, quantities, and other data sources. The analyst should document the estimate such that outside reviewers can track the logic from the assumptions to the conclusion.

(4) The first step in any cost analysis is the development of a study plan. Appendix H provides a study plan outline for any cost analysis.

b. Integrated management framework

(1) Figure 4-1 graphically portrays the key interactions of the DoD Requirements Generation System, Acquisition Management System, and Planning, Programming, and Budgeting (PPBS) System. A synopsis follows.

(2) The Requirements Generation System initially identifies the broad mission needs.

(3) The Acquisition Management System must identify and assess alternative ways of satisfying these needs. The system must consider current and projected technology development, producibility, industrial capability, and support infrastructure constraints.

(4) The PPBS must make initial affordability decisions on proposed acquisition programs based on the Defense Planning Guidance, approved investment plans, and overall funding constraints.

(5) The integrated management framework allows for the progressive translation of the initial, broad MNS into performance goals. The framework then allows these goals to progress to system-specific performance requirements, and finally to a stable system design.

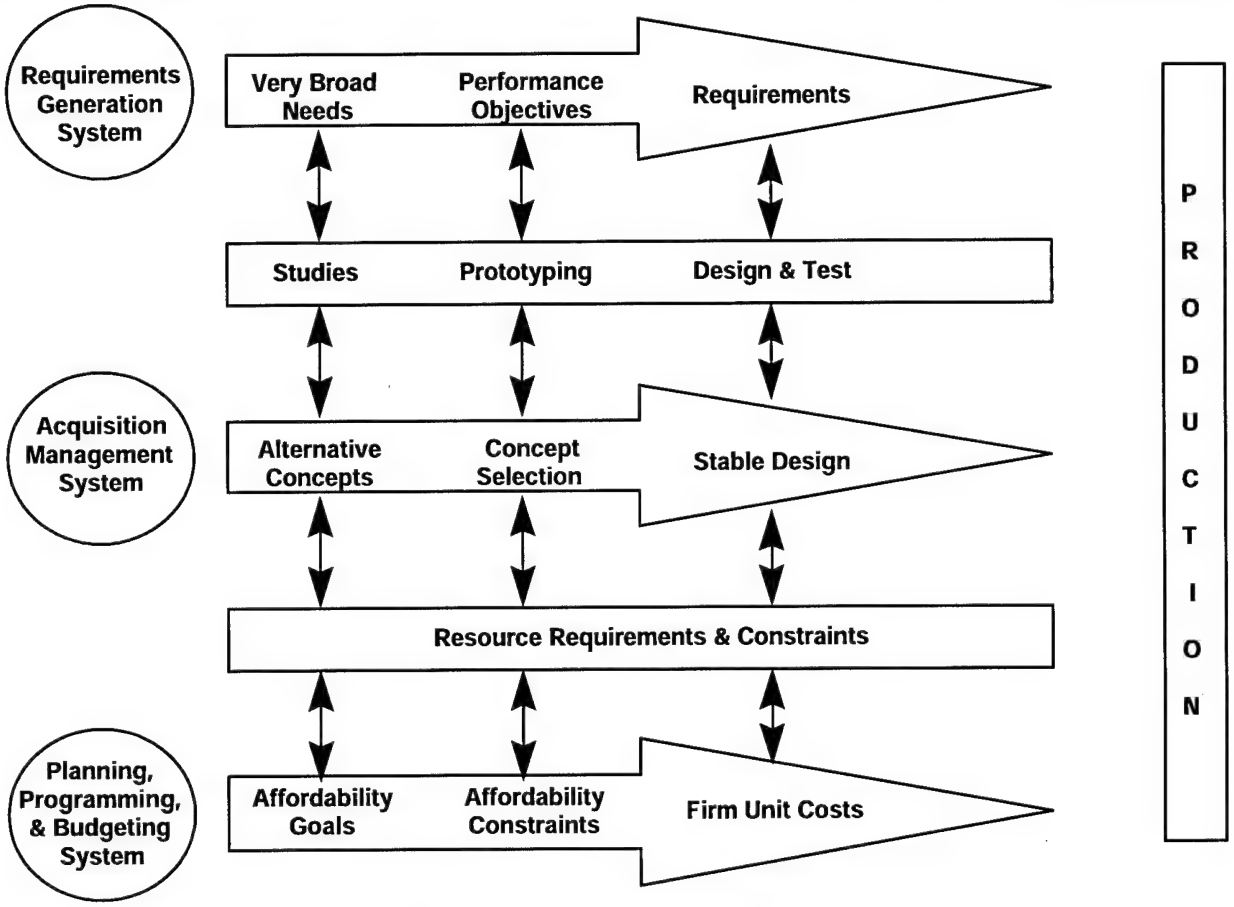


Figure 4-1. Key Interactions

(6) Management must make major cost-performance-schedule tradeoffs throughout the course of program implementation. They base the tradeoffs on threat assessments, status of program execution, risk assessment, test results, and affordability.

c. Life cycle management model

(1) Analysts must address many different costs when performing a cost analysis. Normally, the analyst must estimate all costs from the start through implementation, operation, and disposal for a program or project. Collectively, these costs are the life cycle costs (LCCs). Normally, LCCs in the Army are broken into five parts—Research, Development, Test and Evaluation (RDT&E), Procurement, Military Construction (MILCON), Military Personnel, and Operations and Maintenance (O&M).

(2) Research, Development, Test and Evaluation (RDT&E)

(a) This manual defines RDT&E costs as all costs for system-specific efforts during the demonstration and validation and the engineering and manufacturing development phases from Milestone I through Milestone III. RDT&E costs include all Government costs, both contractor and in-house costs, of products and services necessary to bring a system from concept to production. They also include all costs to the Government of developing the specific capability, without regard to the funding source for such costs.

(b) Estimates of RDT&E costs include all nonrecurring and recurring costs for prototypes, engineering development equipment, and test hardware. Analysts must identify and estimate any contractor system test and evaluation and Government support to the test program. In addition, analysts should consider

such items as support equipment, training, data, and military construction. Finally, analysts should include the cost of all related RDT&E in the estimate, such as redesign efforts necessary to install equipment on existing platforms.

(3) Procurement

(a) This manual defines procurement costs as all costs of buying the prime mission equipment (PME) and its support. Procurement costs cover production through introduction (fielding) of the materiel system into the Army's operational inventory. Examples of cost elements commonly associated with the support portion of the system are support equipment, training, data, and initial spares. A more refined breakout of the cost elements associated with the Procurement costs follows.

(b) Procurement costs include all Government costs, both contractor and in-house costs, of products and services necessary to produce and field an operational system. This includes the hardware, training, and support activities necessary to begin operations. It also includes costs of both a nonrecurring (such as to set up a production capability) and recurring nature (such as repeated production).

(c) Finally, procurement costs include all costs resulting from fielding the system. Fielding is the iterative process of introducing a system to a final user with enough resources (people, materiel, and facilities) to achieve its mission. This requires the integrated efforts of the ARSTAF (policy makers), PM/PEO (system proponent), MACOMs (functional intermediaries), and MTOE or TDA units (final users). The fielding limits (beginning and ending) are a function of the number of fielding interactions for which each group is responsible. An iteration begins when the manufacturer passes ownership of the system to the Government. It ends when the MTOE or TDA unit accepts the system and begins operations with it. The range of fielding limits thus extends from a single iteration for a unit to the ARSTAF, responsible for all iterations.

(4) Military Construction (MILCON)

This manual defines MILCON costs as all costs of system-specific construction. Only projects that are required for the materiel system and will be canceled upon termination of the materiel system are system-specific construction. Examples of system-specific construction projects simulator buildings, missile bunkers, and billets associated with the fielding of new organizations for the new system.

(5) Military Personnel (MP)

This manual defines MP as the military personnel costs associated with the development, production, fielding, operations and support of the materiel system that is not reimbursed by any other appropriation.

(6) Operations and Maintenance (O&M)

(a) Operating and Maintenance costs include all direct and indirect elements of a fielded weapon system. Major cost elements include personnel, unit-level consumption, depot maintenance, sustaining investment, inventory management control, and indirect O&M costs. In general terms, O&M costs include the continuing annual recurring costs of operating and maintaining force structure and materiel systems to perform assigned missions. The level of sustainment is a function of force allocation, training goals, and the operating tempo (OPTEMPO) assigned to individual materiel systems. O&M costs begin with materiel system fielding and end when the materiel system leaves the Army inventory. The length of time associated with steady-state operations also drives the O&M costs.

(b) Also, O&M costs include all costs of the program, regardless of fund source or management control. They also include any measures of the opportunity cost of existing assets or assets available from another source. Also, O&M costs include demilitarization, detoxification, or long-term waste storage.

4- 2. Cost Analysis Requirements Description (CARD)

a. The CARD is key in life cycle costing for major materiel systems. It is the source of a system's description for the development of the POE and CCA. It describes the system's important features, including a description of required resources (such as hardware and personnel), program quantities, and operational concepts for each alternative. With the kick-off of the CARD preparation milestones are identified and published in the Department of the Army Program Cost Analyses.

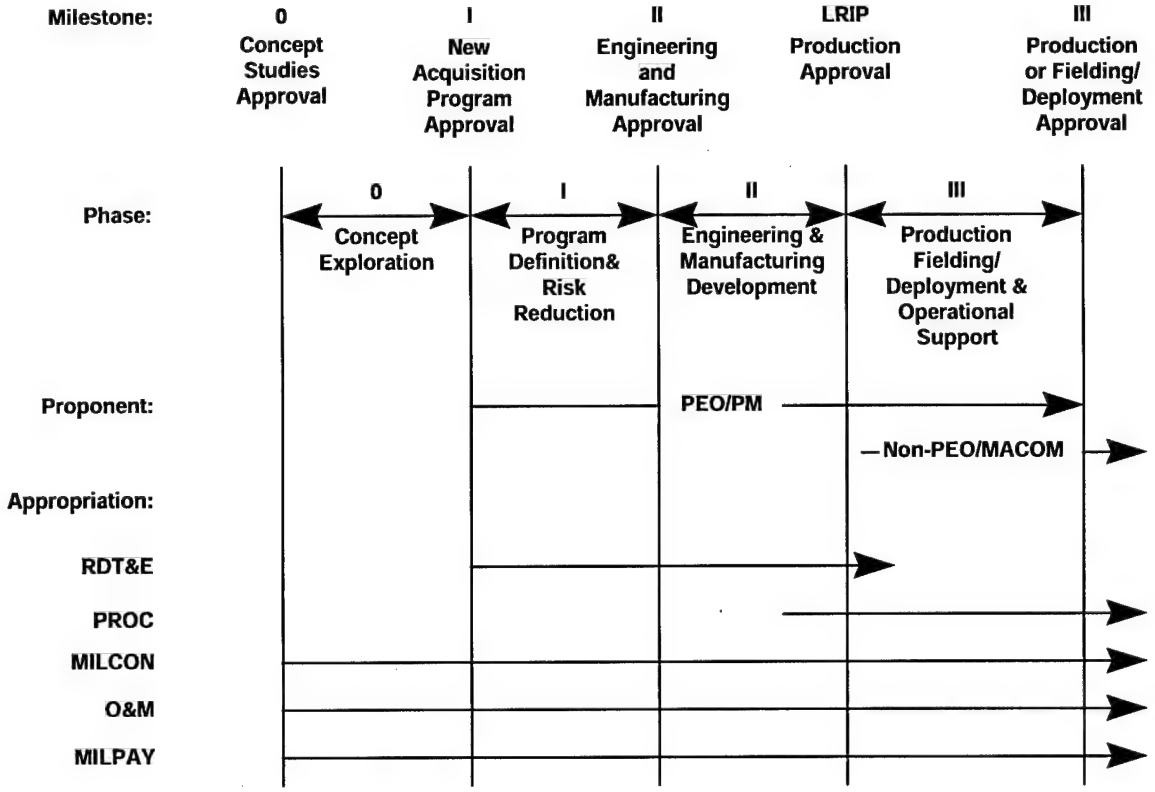


Figure 4-2. Major System Life Cycle Management Model

b. A POE and a CCA shall be prepared for each alternative that will be presented to the DAB or, for delegated programs, to the AAE. The CAIG Chair will coordinate on a complete description of these alternatives, the scope of the estimates to be made, and other related assumptions needed for developing the cost estimates. This information shall be documented in the CARD and used by both the program office and independent cost analysis office.

c. The CAIG requires a preliminary CARD no later than the OSD Milestone Planning Meeting. OSD normally holds this meeting about 180 days before a planned DAB review.

d. A more detailed discussion on the CARD is provided in appendix I.

4- 3. Work breakdown structure/cost element structure (WBS/CES)

a. Introduction

A goal is the consistent preparation and documentation of cost estimates through using uniform cost structures with standardized elements and definitions. A three-dimensional matrix best describes the basic concept of materiel system life cycle costing. One dimension consists of cost elements, another consists of PME, and the third is time (see figure 4-3). The structures and definitions presented in this document support decision making at all levels within the PPBS and defense acquisition management processes. The term milestone costing describes the cost analysis process that normally is event-driven within the acquisition management process. A time-phased matrix and a PME matrix are an integral part of the milestone costing concept. They provide the basis for supplying various decision makers with needed information. These matrices are two-dimensional output formats that combine the CES, PME structure, and time. Section 4-5.d.(6) describes these matrices in detail.

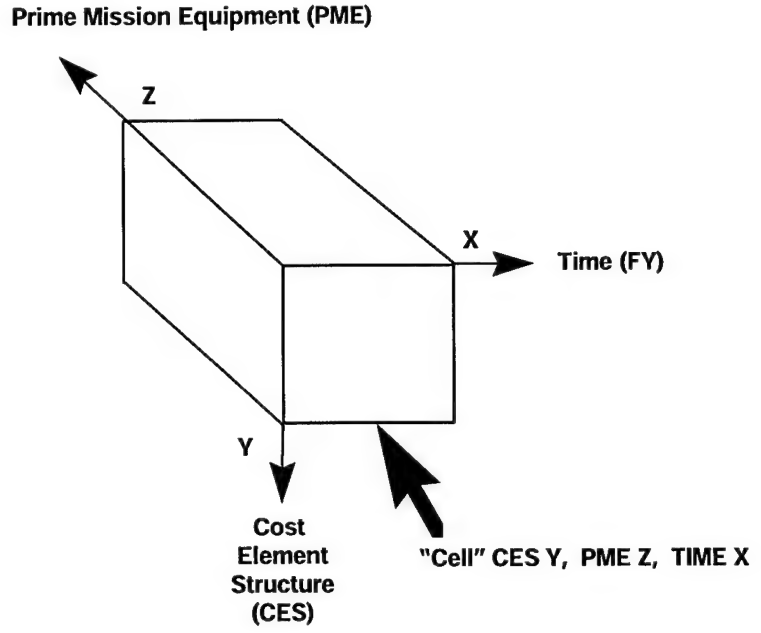


Figure 4-3. Materiel System Life Cycle Costing Matrix Cell

b. Work breakdown structure (WBS)

DoD 5000.2-R requires a WBS for each program. The program WBS defines the total system, displays it as a product-oriented family tree, and interrelates work elements. During the early phases of a program, analysts can use a generic WBS if a program WBS is not yet available. Figure 4-4 presents this evolutionary process of refining the initial WBS. As the program proceeds, the PM will develop a program WBS. Figure 4-5 presents this translation from a generic to a program WBS. Figure 4-6 presents a WBS matrix showing the hierarchical relationships among the elements. This figure presents the total prime mission system WBS of which the PME WBS is a subset. Appendix D presents the PME generic WBS structure for selected types of systems.

c. Cost element structure (CES)

Appendix E presents a CES that incorporates defense management review decisions (DMRDs)/ program budget decisions (PBDs). The CES more closely aligns with the defense acquisition management process (including milestone decision reviews) and the PPBES (including MDEPs and budget forms). Also, the CES incorporates all

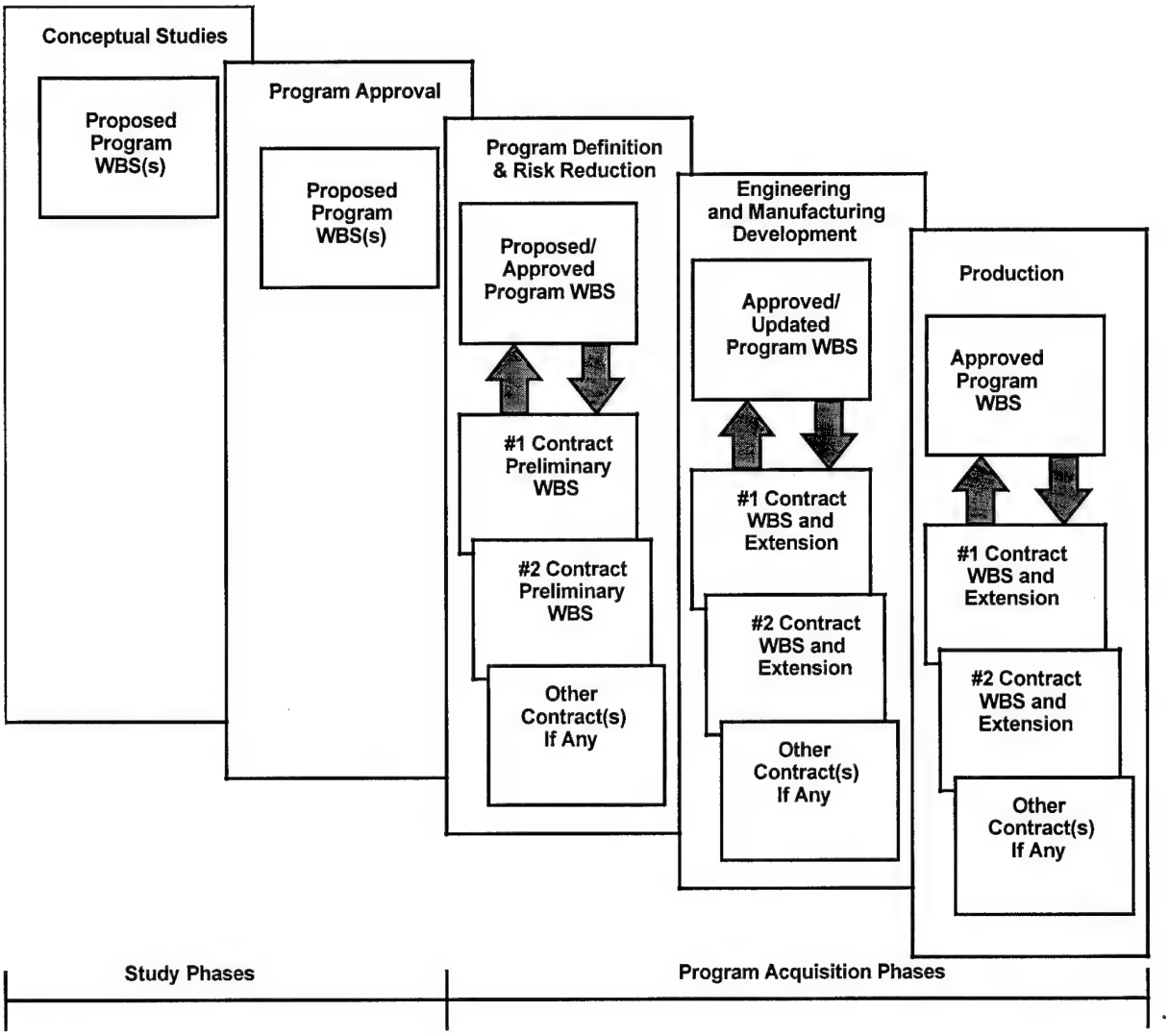


Figure 4-4. The Evolution of a Work Breakdown Structure

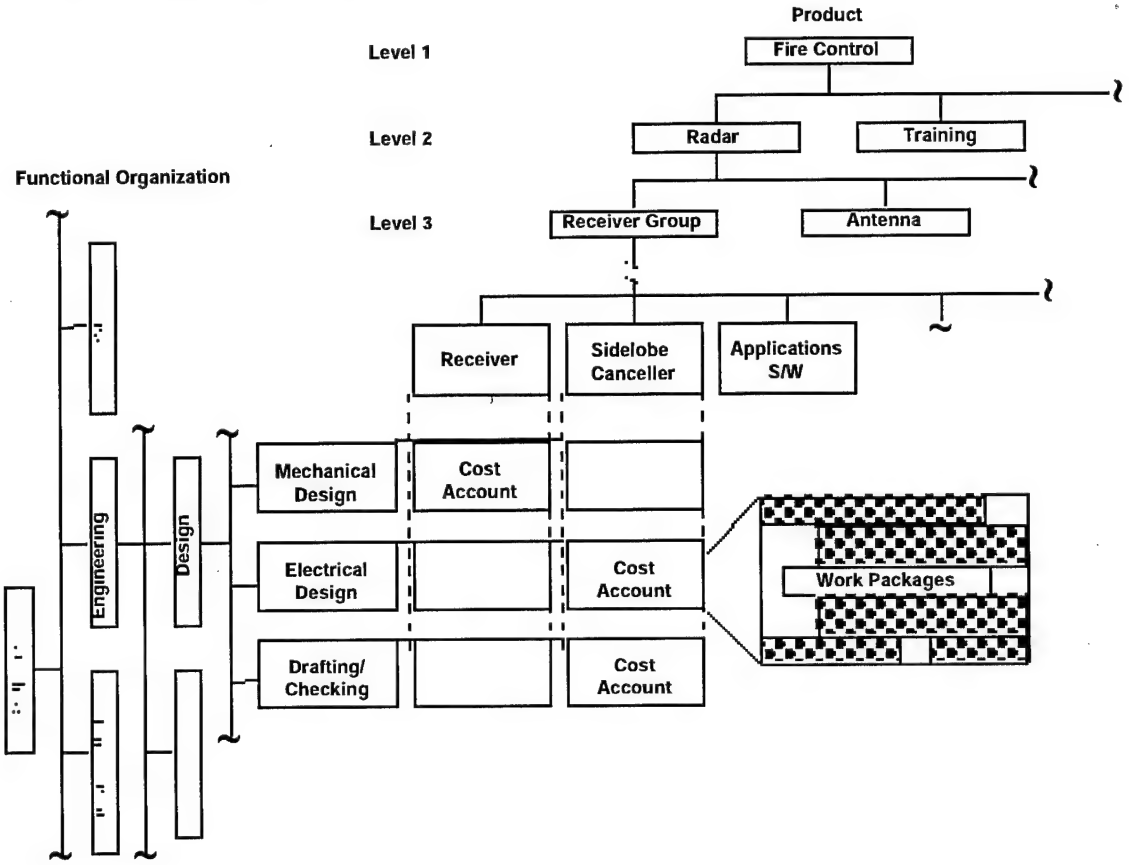
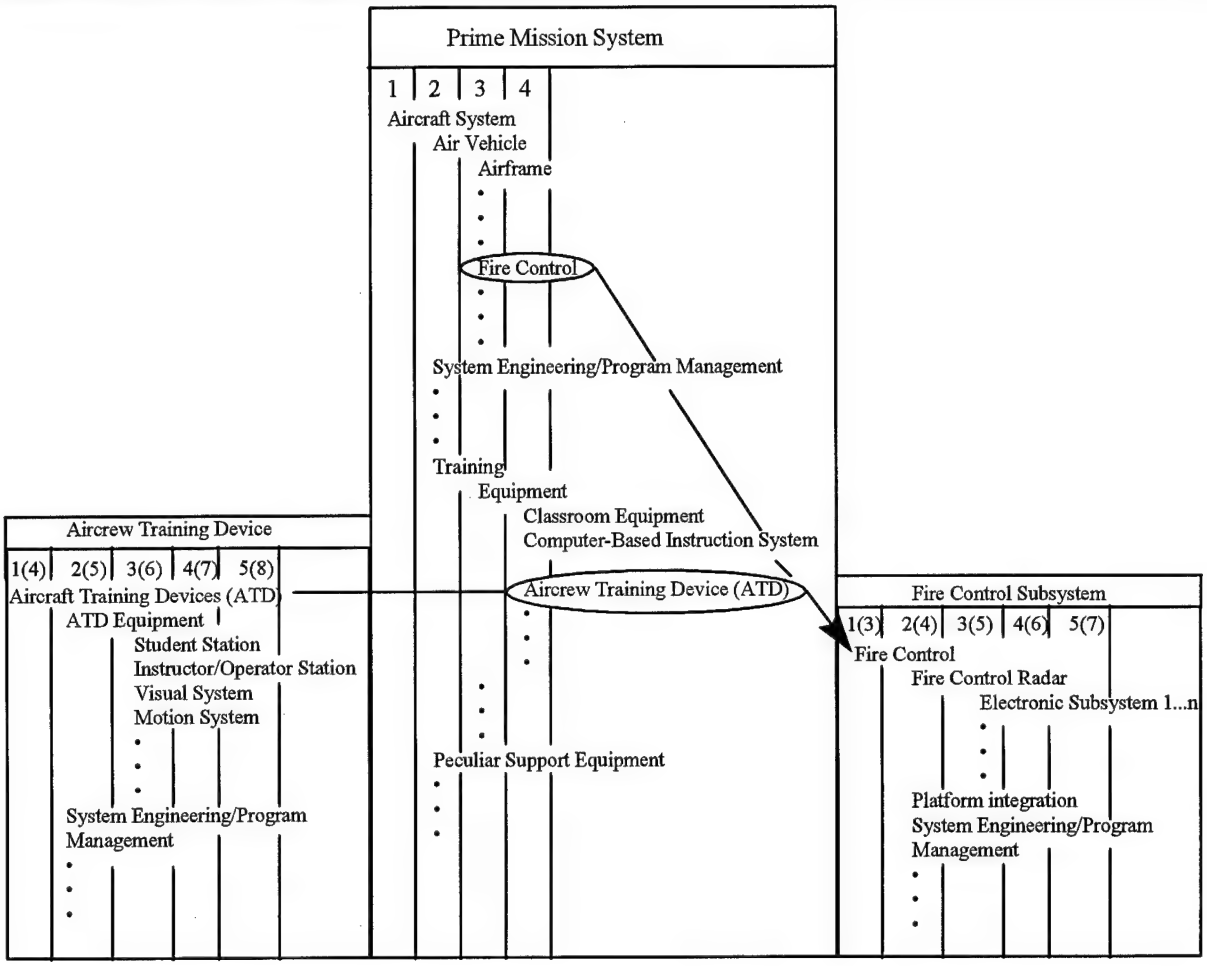


Figure 4-5. MIL-STD-881 Translation from Function to Product



Notes:

1. WBS levels in parentheses indicated relativity to prime mission system (PMS)
2. Level 2 elements (system engineering/program management, system test and evaluation, etc.) for subsystems of the PMS are contained in (i.e., are subelements of) subsystem element. Not the PMS Level 2 elements.
3. Placement of the subsystem in the program work breakdown structure is relative to its WBS breakout for contract application.

Figure 4-6. Work Breakdown Structure Matrix

4- 4. Major materiel systems' cost estimates

a. Program office estimate (POE)

The POE is a specific type of cost estimate. The program and/or product manager develops the POE to support specific acquisition milestone requirements. Significantly, the POE uses cost element definitions common with those used by both the Director of the Army Budget and the Director, Program Analysis and Evaluation. Also, the use of the cost element structure and definitions in appendix E will greatly facilitate the review of the POE. Key to the development of the POE is the CARD that includes information such as the system description, acquisition strategy, fielding plan, and operational concepts. The POE should reflect the program described in the CARD. The analysis behind the POE is of utmost importance. The POE should embody the principles of

analysis and the application of the scientific method. Specifically, the analysis must be objective and supported by a data base relevant to the system. Each part of the estimate must be consistent with each other part and clearly identify key cost driver assumptions. The estimate must be complete in the coverage of all costs. Also, it must be forthright in stating the shortcomings and risks in the estimate. Finally, the POE should convey to the decision maker, in a "truth in lending" sense, what the estimate does and does not represent. The POE is an LCC estimate, documented and reflecting a snapshot in time. Section 4-5.d. discusses the specific documentation required for the POE. Figure 4-7 shows the POE/CCA/ACP milestone time lines for ACAT ID, IC, and II systems

b. Component cost analysis (CCA)

(1) The CCA is another type of cost estimate. An agency not in the acquisition community develops the CCA to support specific regulatory acquisition milestone requirements. Analysts use the CCA to test the reasonableness of the POE. For major materiel systems, CEAC develops this estimate. Independence is the key in the conduct of the CCA. Independence does not mean that the CCA analyst is uninformed about the POE and its methodology; rather, it means that the analysis behind the CCA takes a different, independent approach from the POE. Otherwise, the CCA has all the characteristics of the POE. The CCA is a life cycle estimate, documented and reflecting a snapshot in time. Section 4-5.d. discusses the specific documentation required for the CCA. The CCA meets the statutory requirement for the ICE on ACAT IC programs. Figure 4-7 shows the POE/CCA/ACP milestone time lines for the ACAT ID, IC, and II systems.

(2) Independent cost estimates shall include all program costs, regardless of funding source or management control. This includes system integration and modification costs, logistics support costs, and military construction costs. Significant deficiencies in the cost estimates or their documentation may lead to deferment of the milestone review.

(3) DoD components shall not contract for development of CCAs without prior written approval of the CAIG Chair. Requests must demonstrate that special circumstances require use of contractor, vice organic, personnel for the CCA, and that adequate safeguards will protect against conflicts of interest.

c. Army cost position (ACP)

The ACP is the Army's approved LCC estimate for the materiel system. It is the basis for Army planning, contracting, programming, budgeting, and execution. For DoD milestone reviews, the ACP satisfies the DoD 5000.2-R requirement for a Component cost position. The ACP is also a snapshot in time as are the POE and CCA. The Cost Review Board (CRB) recommends approval of the proposed ACP after an intensive review of both the POE and CCA. The first step in developing an ACP is to compare the POE to the CCA. This is to ensure that both estimates represent the same scope of work defined in the CARD. Otherwise, the CRB working group must adjust either the POE or the CCA. Any remaining difference is with estimating methodology. The CRB working group then analyzes the POE and CCA to check whether the data and methodology employed were correct and properly used. The CRB working group should make a comparison to locate the cost elements (or PME subelements) where differences are greater than 10 percent. The CRB must judge which methodology is **most** reasonable and sound. This judgment process is not a matter of negotiation with the POE preparer; rather, it is a matter of objective reasoning. The ASA(FM&C) approves the ACP for the AAE. When approved, the ACP is the reference for all planning, contracting, programming, and budgeting for the system. The cost analysis brief (CAB) documents the rationale for reconciling the POE and CCA to form the ACP. Section 4-5.d. discusses the specific documentation required for the ACP. Figure 4-7 shows the POE/CCA/ACP milestone time lines for ACAT ID, IC, and II systems.

Event	Date (Calendar Days)
ACAT ID Timeline	

Receive CARD	D -	194 days *
CAIG Planning Meeting	D -	166 days
POE and CCA Documentation Provided CRB	D -	135 days
ACP Approved	D -	105 days
Preliminary ASARC	D -	90 days
ASARC	D -	60 days
Draft POE/CCA/ICE/ACP Documentation to DAB Secretary	D -	59 days *
Brief CAIG	D -	35 days *
Documentation due	D -	24 days *
OIPT	D -	14 days *
DAB	D day	

* OSD required. IPT Process other dates flexible

ACAT IC Timeline

Receive CARD	A -	166 days
CAIG Planning Meeting	A -	166 days
POE and CCA Documentation Provided CRB	A -	75 days
ACP Approved	A -	45 days
Draft POE/CCA/ICE/ACP Documentation to CAIG	A -	45 days
Preliminary ASARC	A -	30 days
Brief CAIG	A -	21 days
Final POE/CCA/ICE/ACP Documentation to CAIG	A -	10 days
ASARC	A day	

ACAT II Timeline

Receive CARD	A -	165 days
POE and CCA Documentation Provided CRB	A -	75 days
ACP Approved	A -	45 days
Draft POE/CCA/ICE/ACP Documentation to ASARC Secretary	A -	45 days
Preliminary ASARC	A -	30 days
Final POE/CCA/ICE/ACP Documentation to ASARC Secretary	A -	10 days
ASARC	A day	

Figure 4-7. Milestone Time Lines for POE/CCA/ACP

d. Independent cost estimate (ICE)

The ICE is required by 10 USC 2434 (Independent cost estimates, operational manpower requirements). The ICE for ACAT ID is usually prepared by the OSD CAIG. When OSD delegates the decision authority to the Army Acquisition Executive for ACAT I systems, then CEAC is responsible for the ICE that meets the statutory requirement.

4- 5. Documentation requirements

a. General

(1) Documentation should be clear, concise and display consistency in each study. The goal of the cost documentation process is to provide cost-estimating reports that are readable, auditable, and useful. The analyst should index the documentation for easy and rapid access. The basic needs of documentation are to record:

(a) All ground rules and assumptions used in developing the estimate.

(b) The data used in the estimate and their sources.

(c) The analyst's treatment of the data (for example, normalization and cause-and-effect determinations).

(d) The cost-estimating relationships used in the estimate, their sources and limitations.

(2) There should be enough documentation to enable a person unfamiliar with the estimate to reconstruct the same results as the person who conducted the analysis. The reviewer, or the decision maker, may delay the project if unable to follow the assumptions, data, and computations. Normally, it pays to take the time and effort to document the analysis adequately.

b. Cost calculation rules

(1) Cost analysts must avoid the pitfall of confusing precision (the number of significant figures) with accuracy. The accuracy of the least accurately known factor limits the accuracy of a product of numbers. This is regardless of the number of digits used to express the product.

(2) In the real world, incomplete data and information limit the analyst. The practical rule in cost estimating is to limit the precision of the estimate to the level needed to support the requirement. For example, it is standard in materiel system budget documents to limit the report to the nearest $100,000. Here an estimate carried to $1,000 has no significance and adds nothing to the process. However, for high-volume piece parts, manufacturers make production decisions at the unit-cost level of $.01 or less. This is where $.01 is a significant percentage of the unit cost.

(3) One rule on significant figures limits an arithmetic product's significant figures to the least number of significant figures of any of its factors, excluding integers. (Treat an integer value as having an infinite number of zeros to the right of the decimal point.) For example, using a factor such as 1.0143 to inflate a constant-dollar estimate of $2.0 million (two significant figures), the simple arithmetic product is $2.0286 million. However, when the rule of significant figures is applied, the two-significant-figure estimate is only $2.0 million in inflated dollars. If, however, the constant-dollar value is $20.0 million (three significant figures), the result is $20.3 million. This illustrates that a 1 percent inflation increase to a $2.0 million estimate is below the level of significance. However, it is significant at the $20.0 million level.

(4) A second rule on significant figures limits the number of significant figures to the right of the decimal point when summing. Limit the summation to the number of significant figures to the right of the decimal point of the least precise term.

(5) For briefings and presentations, the analyst should be mindful of both the audience and the estimate's credibility. Never burden an audience with extraneous information or numbers of superfluous digits. Never suggest that cost estimating can imply more accuracy or precision than can be justified and delivered.

c. Cost documentation concept

(1) Figure 4-8 shows the relationships among the various elements of the cost documentation module. The Cost Documentation Format (CDF) is the central element of the cost documentation module. The Variable Explanation Format (VEF) provides the explanation and data that support the methodology and

calculations on the CDF. It should be noted that the CDF and the VEF are not forms or specific formats to be used verbatim as shown. Rather, the contents of the CDF and the VEF are important.

(2) The key to this documentation concept is the ability to track data from one format to another. The goal of these formats is to provide direct links among the various displays without undocumented excursions. For example, the results portion of the CDF provides the costs for the Cost Summary Format when used. Otherwise, the costs on the CDF go directly to the PME and time-phased matrices.

(3) Figure 4-8 does not display the MDEP, SAR, contract support, and other PPBES matrices because they are system specific. However, the data used to develop these displays should come directly from the CDF and the VEF.

d. Program office estimate/component cost analysis documentation

(1) The POE and CCA have the same documentation requirements. The CCA can accept costs for nondevelopmental or commercial hardware as throughput from the POE. Additional throughput from the POE to the CCA requires the approval of the OSD CAIG. In all cases, the CCA analyst will challenge the data before accepting any throughput costs.

(2) A variety of activities will review the POE/CCA documentation. Examples are MACOMs, HQDA, OSD, Congress, General Accounting Office (GAO), Army Audit Agency (AAA), and DoD Inspector General. None of these reviewers will be as familiar with the POE or the CCA as the analyst that prepared it. Yet, the reviewer will critically analyze and pass judgment on the analysis' adequacy based on available documentation. For this and other reasons, the analyst must fully document the sources of the cost data and the cost-estimating methods. The POE/CCA documentation should include enough information for each cost element to provide reviewers with all the evidence required to confirm the POE/CCA.

(3) The documentation should specify the data bases (and methods) considered and the rationale for the selection of one data base (or method) over all others. Actual cost experience, from CCDR and other data sources, on prototype units, early engineering development hardware, and early production hardware for the program under consideration, should be used to the maximum extent possible. If development or production units have been produced, the actual cost information shall be provided as part of the documentation. Estimates for Milestone III reviews must be based at least in part on actual production cost data for the system under review. Beyond those identified in the CARD, the documentation should address any additional constraints imposed. The analyst should identify any ground rules, assumed or imposed, and their underlying rationale. Also, the analyst should provide an evaluation of the limitations and constraints of the estimate for each cost element.

(4) The sensitivity of projected costs to critical program assumptions shall be examined in both the POE and the CCA. Aspects of the program to be subjected to sensitivity analysis shall be identified in the independent analysis of program assumptions. The analysis shall include such factors as learning curve assumptions, technical risk of increased development and/or production effort, changes in performance characteristics, schedule alterations, and variations in testing requirements. Program offices will support CEAC in identifying risk areas and assessing their potential cost effects. The use of statistical analysis to describe the sensitivity of critical assumptions shall be documented and provided to the CAIG. The POE and CCA analysts shall identify and quantify areas of program uncertainty. Uncertainty will be quantified by the use of probability distributions or ranges of cost (see section 3-7). The probability distributions, and assumptions used in preparing all range estimates, are documented in the POE or CCA.

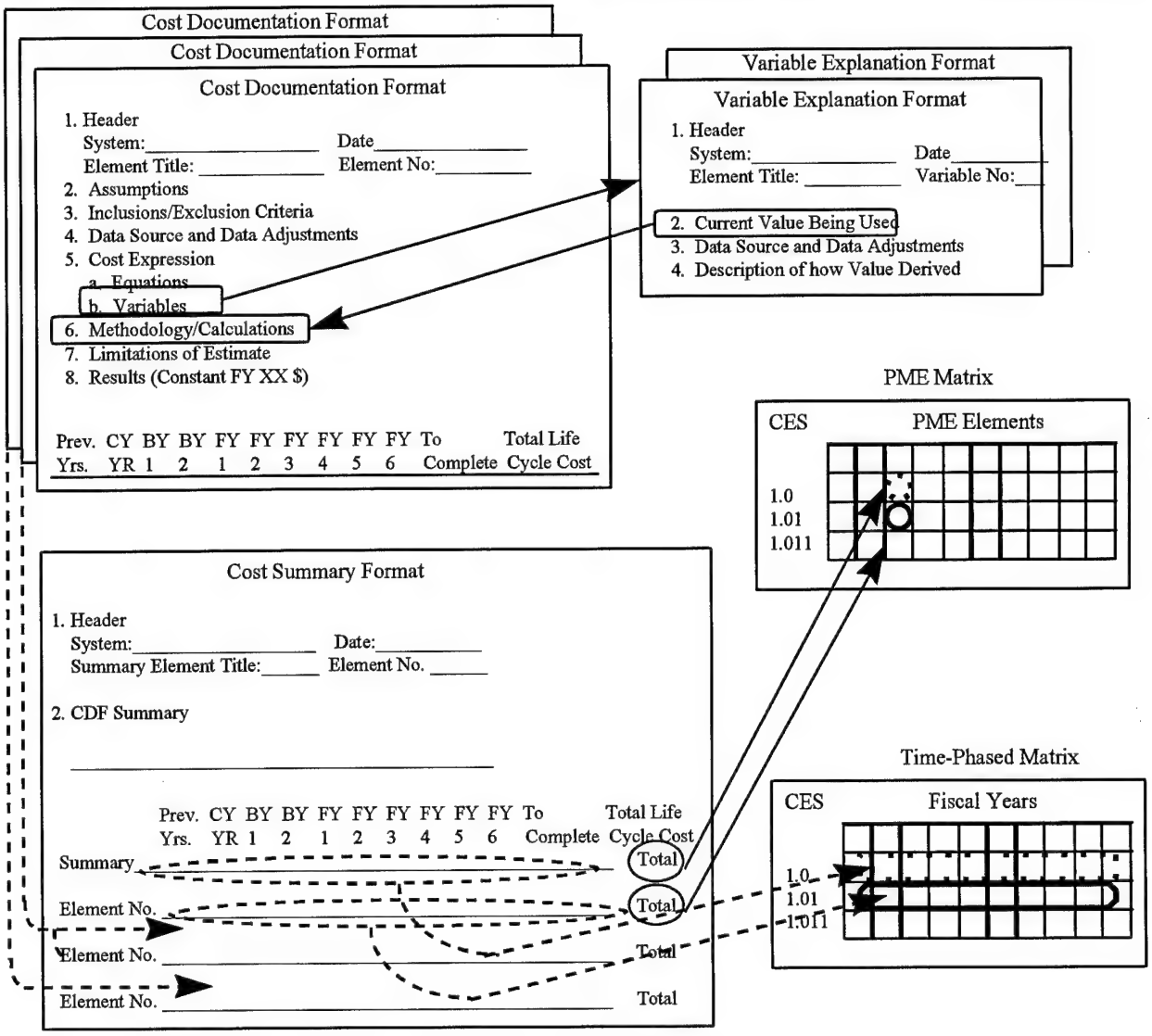


Figure 4-8. Cost Documentation Concept

(5) The goal of developing standard documentation criteria is to produce reports that are readable, auditable, and useful. The analyst must prepare a set of documentation formats for each element (or PME subelement), except totals. The analyst should provide the rationale for estimating zero cost. A description of the documentation formats follows.

(6) Documentation formats

(a) Appendix H provides an outline for a study plan.

(b) Figure 4-9 provides an outline for the POE or CCA. The executive summary should be a short, stand-alone document that summarizes the POE or CCA for the decision maker. Sections I and II can be in one or more volumes.

Executive Summary

A. Introduction
   — Preparing Organization
   — Purpose

B. Program Description

C. Assumptions, Ground Rules and Constraints

D. Cost Summary

E. Summary Cost Comparison (current versus previous estimates)

Section I. Cost Documentation

A. Estimate Overview
   — Purpose
   — Program Description
   — Ground Rules, Assumptions, and Constraints
   — Risk Analysis
   — Sensitivity Analysis
   — Evaluation of Limitations and Constraints
   — Reconciliation with Fiscal Guidance

B. Cost Summary Formats (includes required matrices)

C. Cost Documentation Formats
   — CDFs
   — VEFs

Section II. Appendices

A. CARD

B. Program WBS

C. CDF/VEF Specific References (including data sources)

D. General References

E. Other (NOTE: Other appendices can be added for such items as risk analysis or sensitivity analysis.)

Figure 4-9. POE/CCA Outline

(c) Figure 4-10 presents the Cost Documentation Format.

COST DOCUMENT FORMAT

1. HEADER.

   SYSTEM: _____ DATE: _____

   ELEMENT TITLE: _____ ELEMENT NO. _____

2. ASSUMPTIONS.

3. INCLUSION/EXCLUSION CRITERIA.

4. DATA SOURCE AND DATA ADJUSTMENTS.

5. COST EXPRESSION.

   a. EQUATION:

   b. VARIABLES:

6. METHODOLOGY/CALCULATIONS.

7. LIMITATIONS OF ESTIMATE.

8. RESULTS (CONSTANT FY XX $).

PREV YRS	PR YR	CU YR	BY 1	BY 2	FY 1	FY 2	FY 3	FY 4	FY 5	FY 6
TO COMPLETE			TOTAL LIFE CYCLE COST							

Figure 4-10. Cost Documentation Format

The CDF is an expansion of the Cost Data Sheet concept employed before in cost estimate documentation. The expansion as designed will more completely accomplish the goals of documentation. The header information on the CDF will help the reader quickly identify which segment of the cost estimate the analyst is explaining. The CDF calls for eight types of information:

1) **HEADER**. This section should identify the system, cost element (or PME subelement) title and number, and date of the documentation.

2) **ASSUMPTIONS**. The analyst should clearly state all assumptions. These assumptions are about this element only and are not just a repeat of the overall ground rules and assumptions for the basic study. As an example, a study ground rule may be that the analyst will complete the estimate in constant FY XX dollars. A specific assumption for this element might be the use of a specific composite material, or only one production shift.

3) **INCLUSION/EXCLUSION CRITERIA**. A listing of the inclusion/ exclusion criteria should provide a simple explanation of the element the analyst is costing.

4) **DATA SOURCE AND DATA ADJUSTMENTS.** The analyst should identify all data sources and any adjustments.

5) **COST EXPRESSION**. The cost expression should provide the basic equation used to calculate the results and a listing of variables unique to this element. The analyst should document all recurring variables using the VEF.

6) **METHODOLOGY/CALCULATIONS.** The analyst should include in this section a basic summary of the methodology, techniques, and calculations used to compute the estimate.

7) **LIMITATIONS OF ESTIMATE**. The analyst should present the limitations and constraints of the estimate. In this section of the CDF, the analyst provides insight about the strengths or weaknesses of the estimate. For example, this section might include statements such as "the estimate is valid for production rates up to 100 per month and above 100 invalidates the methodology."

8) **RESULTS**. These results should track directly to the PME matrix and time-phased matrix discussed below. As a minimum, the analyst should present sunk costs in two parts—a prior year (PR YR) and a rollup of all previous years. Follow sunk costs with the current fiscal year (CU YR). Next follow with both budget years (BY1 and BY2) as required when the current year is the last year of the past budget. As a representative CDF, figure 4-10 shows 6 fiscal years beyond the budget (FY 1 to FY 6). A TO COMPLETE column finishes the TOTAL LIFE CYCLE COST display. The analyst may provide additional fiscal displays when required. For example, the PPBES requirements may include extended planning annex displays.

(d) The analyst should use the VEF (see figure 4-11) to document all recurring variables.

VARIABLE EXPLANATION FORMAT

1. **HEADER.**

   SYSTEM: _____ DATE: _____

   VARIABLE TITLE: _____ VARIABLE NO. _____

2. **CURRENT VALUE BEING USED.**

3. **DATA SOURCE AND DATA ADJUSTMENTS.**

4. **DESCRIPTION OF HOW VALUE DERIVED.**

Figure 4-11. Variable Explanation Format

Place the VEFs at the end of the documentation in alphabetic/numerical order. The VEF is an expansion of the Variable Explanation Sheet concept employed before in cost estimate documentation. The expansion as designed

will more completely accomplish the goals of documentation. The VEF header provides quick identification of which cost estimate segment the analyst is explaining. The VEF calls for four types of information:

1) **HEADER**. This section should identify the system, variable title and number, and date of the documentation.

2) **CURRENT VALUE BEING USED.** This is a statement of the variable's numerical value used in this estimate.

3) **DATA SOURCE AND DATA ADJUSTMENTS.** The analyst should identify all data sources and any adjustments.

4) **DESCRIPTION OF HOW VALUE DERIVED**. The analyst should include in this section a basic summary of the methodology, techniques, and calculations used to determine the value of the variable.

(e) When appropriate, the analyst may use a Cost Summary Format (figure 4-12) to total the results from several CDFs for convenience.

COST SUMMARY FORMAT

1. **HEADER.**

SYSTEM: _____ **DATE:** _____

SUMMARY ELEMENT TITLE: _____

ELEMENT NO. _____

2. **CDF SUMMARY:** _____

PREV YRS	PR YR	CU YR	BY 1	BY 2	FY 1	FY 2	FY 3	FY 4	FY 5	FY 6	TO COMP	TOTAL COST

SUMMARY_____

ELEM NO:_____

ELEM NO:_____

ELEM NO:_____

ELEM NO:_____

ELEM NO:_____

ELEM NO:_____

Figure 4-12. Cost Summary Format

(7) Required matrices

(a) This guide identifies three matrices basic to the presentation of the POE/CCA. The required matrices are a PME matrix, a time-phased matrix, and an MDEP matrix to support PPBES analyses. A discussion of each of these matrices follows. The analyst may use additional matrices to support specific customer or presentation requirements. As an example, the analyst only presents the matrices described in section 4-7.d.(3) when the CAIG receives the cost estimate.

(b) The PME matrix provides an LCC total by cost element and PME. Figure 4-13 presents this matrix.

Cost Element	PME/PMP Breakout					Other	Total
	PME 1	PME 2	PME 3	•••	PME n		
1.0 RDTE • • •							
2.0 Procurement • • •							
3.0 MC • • •							
4.0 MP • • •							
5.0 O&M • • •							
6.0 AWCF • • •							

Figure 4-13. PME Matrix

(c) The time-phased matrix presents, in a two-dimensional format, three discrete concepts, i.e., time, cost element, and PME. This matrix provides the lowest level of detail in the documentation of the cost estimate. It also serves as the basis for the analyst to complete all data calls. The horizontal axis displays the time dimension. Figure 4-14 shows a sample time-phased matrix with a limited fiscal year display. The fiscal year display matches that shown in the CDF. The analyst can expand or regroup the fiscal year display to meet specific needs, such as an extended planning annex display. The vertical axis displays the cost elements, including the PME as subelements of the cost elements.

Cost Element	Previous Years	PR YR	CY YR	BY 1	BY 2	FY 1	FY 2	FY 3	FY 4	FY 5	FY 6	To Complete	Total Life Cycle Cost
1.0													
1.01													
PME 1													
PME 2													
•													
•													
•													
PME n													
1.02													
PME 1													
PME 2													
•													
•													
•													
PME n													
•													
1.05													
1.051													
1.052													
•													
•													
•													

Figure 4-14. Time-Phased Matrix

(d) Various elements of the CES can be crosswalked to the materiel system's unique MDEPs. Figure 4-15 presents the classes of MDEPs. (Note: Not all cost elements from a system's LCC estimate will map directly into specific MDEP(s).)

A	-	Logistics	
		AM - Maintenance Activity	AS - Supply Activities
		A2 - Second-Destination Transportation	
BR	-	Base Realignment Cost	
BS	-	Base Realignment Savings	
CD	-	Combat Developments	
D	-	Mobilization/Deployment	
E	-	Engineer Revitalization and Activities	
FA	-	Field Operating Agencies	
FL	-	Fielding Systems (Intensively Managed Non-PEO)	
FP	-	Fielding Systems (PEO Intensively Managed)	
GP	-	National Foreign Intelligence Programs	
HS	-	Health Services/Medical Activities	
J	-	Joint/DoD Activities	
M	-	Information Systems	
		MP - PEO Managed	MS - Non-PEO Intensively Managed
		MT - Non-PEO Tactical	MU - Non-PEO Sustaining Base
		MX - Non-PEO Support Activities	
NG	-	National Guard Activities	
PA	-	Pay and Subsistence Active Component	
PN	-	Pay and Subsistence National Guard	
PR	-	Pay and Subsistence	
PE	-	PEO Operations	
Q	-	SIO	
R	-	RDA (Non-IM or PEO Managed)	
		RA - Close Combat	RB - Fire Support
		RC - Air Defense	RD - Aviation
		RE - AMMO	RF - EMW
		RG - NBC	RH - IEW
		RJ - CSS	RK - STB (Tech Base)
		RL - Test Evaluation	RN - Base Support
		RP - Training	
S	-	Sustaining	
		SL - Sustaining Systems (Intensively Managed Non-PEO)	
		SP - PEO Sustaining Systems (Intensively Managed)	
T	-	Training	
		TA - Active Force	TF - Other Services
		TB - Simulators/Training Devices	TN - NGB
		TC - Combined Training Centers	TR - SAR
		TD - Joint/Defense	TS - Support
USM	-	U.S. Military Academy	
V	-	Special Visibility	
W	-	MTOE Organizations	
X	-	TDA Activities	
		XC - Army Man Review Cost	XS - Army Man Review Savings
ZQ	-	Structure Realignment Costs and Savings	

Figure 4-15. Classes of MDEPs

Figure 4-16 presents an MDEP outline showing the different combinations (program elements, projects, and Standard Study Numbers (SSNs)s) possible for materiel systems (both major and non-major). Normally all RDT&E and procurement-funded activities in the time-phased matrix should map directly to a single system's MDEP. MCA cost elements should track to specific Military Construction, Army (MCA) project numbers in the system's MDEP.

Cost Element	Previous Years	PR YR	CY YR	BY 1	BY 2	FY 1	FY 2	FY 3	FY 4	FY 5	FY 6	To Complete	Total Life Cycle Cost
RDT&E													
PE/Project #1													
PE/Project #2													
PROC													
SSN #1													
SSN #2													
OMA													
PE #1													
PE #2													
MCA													
Project #A													

Figure 4-16. MDEP Outline

4- 6. Cost Review Board (CRB)

a. Overview.

(1) The Assistant Secretary of the Army for Financial Management and Comptroller (ASA(FM&C) formed the Army Cost Review Board (CRB) to review cost estimates for major weapon and information systems. This was in response to the need for a comprehensive Army Cost Position (ACP) acceptable to both the acquisition and financial management communities and to support the Planning, Programming, Budgeting and Execution System (PPBES). This chapter addresses these needs and is in keeping with the DoD 5000 series guidance dated 15 Mar 96.

(2) The ASA(FM&C) is responsible for approving the recommended Army Cost Position (ACP) which is forwarded to the AAE and then briefed following the ASARC, MAISRC, or DAB briefing patterns. The task of recommending an ACP falls on the Cost Review Board (CRB) Chairperson who is the Principal Deputy ASA(FM&C). The CRB Chair exercises the Army's financial management control responsibility through the operation of the Cost Review Board. The CRB uses the Integrated Product Team (IPT) approach. This approach improves the quality of the ACP by bringing together experts from the acquisition, combat developments, financial management, and logistic communities. The membership of this board provides a broad range of Army perspectives and experiences required for making sound decisions. The CRB reviews major weapon and information systems at their critical acquisition decision points. All Army and Joint Army ACAT I programs and programs of special interest must have a recommended ACP briefed to the CRB.

(3) The Cost Review Board consists of

(a) Principal Deputy, Assistant Secretary of the Army (ASA), Financial Management & Comptroller (FM&C) is the Chairperson of the CRB

(b) Deputy for Cost Analysis ASA(FM&C) is the Non-Voting Secretary of the CRB

and the principals from the following organizations:

(c) Permanent Voting Members:

1) Deputy, Chief of Staff for Operations and Plans, Army Staff

2) Deputy Director, Program Analysis & Evaluation Directorate, Army Staff

3) Director, Assessment & Evaluation, ASA(RD&A)

4) Deputy, for Plans, Programs, & Policy, ASA(RD&A)

5) Vice Director, Information Systems for Command, Control, Communications and Computers (DISC4)

6) Assistant Deputy for Army Budget, ASA(FM&C)

7) Chief, Cost and Economic Analysis Division, Headquarters, Army Materiel Command

8) Chief of Cost, Training & Doctrine Command

9) Functional Proponent Representative (Information Systems only)

(d) Ad Hoc, Non-Voting Members:

1) Representative from the systems Program Executive Office

2) Other experts the CRB Chair deems necessary (e.g., OSD CAIG Analyst)

(4) The following diagram shows that the CRB principals are represented among the membership of a typical program Cost IPT.

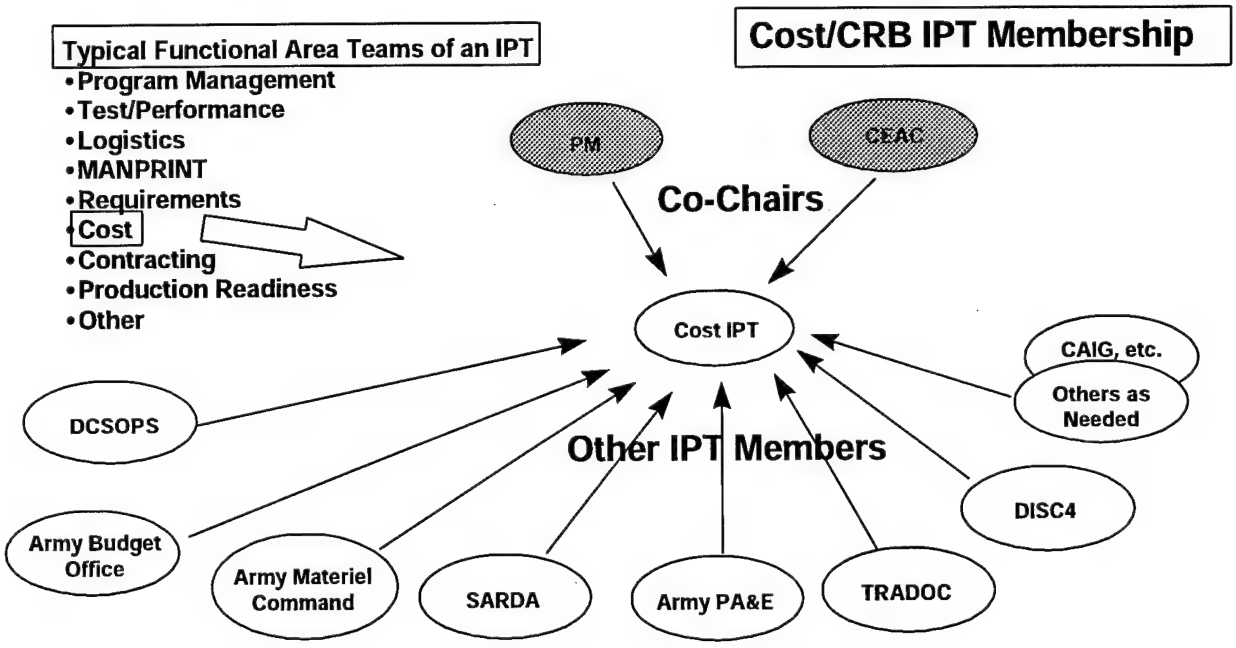


Figure 4-17. Membership Of The Cost/CRB IPT

b. Program Categories:

(1) ACAT ID Programs. The OSD CAIG will develop an ICE for ACAT ID programs as part of the DAB process. The CRB Executive Secretary may decide that it is in the Army's interest to perform some additional form of independent analysis based on the programs level of risk, maturity, cost growth, etc.

(2) ACAT IC Programs. Recent OSD guidance states that the OSD CAIG unless otherwise notified, delegate the development of the Independent Cost Estimate for ACAT IC programs and has passed that function to the component services. For Army ACAT IC programs CEAC will be develop the ICE for consideration during the ASARC process.

(3) In either situation the recommended ACP must provide to the ASA(FM&C) for approval. Figure 4-18 below shows the recommended ACP process as a two stage process. Stage I activities and products take place under the Cost IPT process, while stage II activities and products are part of the CRB IPT process. The members and leadership of both groups are essentially the same and the entire process can be referred to as the Cost/CRB IPT process with the understanding that stage I and stage II processes and products are different.

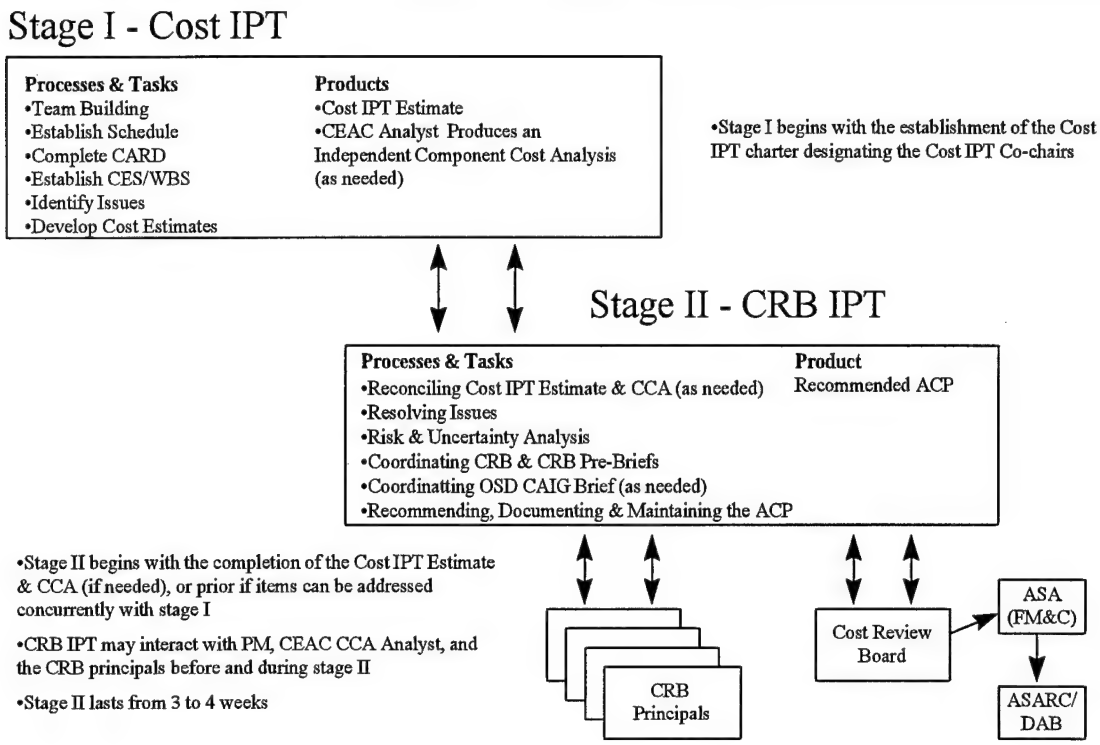


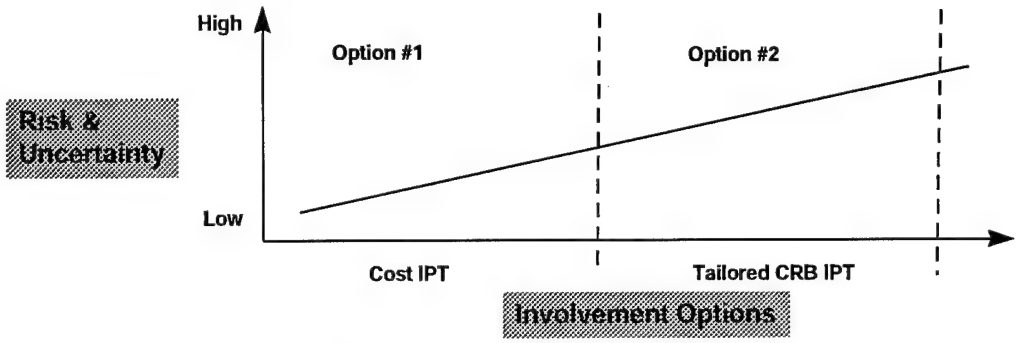
Figure 4-18. The ACP Process

c. Program Reviews:

(1) ACAT ID Programs. The OSD CAIG performs an independent estimate which fulfills the statutory requirement for an independent cost and manpower estimate. However, as noted above Army leadership may decide to do CCA for an ACAT ID program based on the program's level of risk and uncertainty. Therefore, for ACAT ID programs there are two options for the Cost/CRB IPT. If there are no risk and uncertainty issues with the program, the Cost IPT estimate may be sufficient for a recommended ACP. The Cost IPT co-chairs, in coordination with the CRB Support Office and the CRB Executive Secretary, make an initial and on-going assessment of program risk and uncertainty. Based upon the initial assessment or emerging issues, the Cost/CRB Co-chairs may recommend one of two involvement options for the CRB to the CRB Executive Secretary.

(a) Option 1. CRB Executive Secretary decides that the program has no significant risk and the Cost/CRB IPT can go forward with the Cost IPT estimate. The Cost/CRB IPT will then document the estimate, do a risk analysis, and this will become the recommended ACP. After this has been briefed to the CRB and any needed changes have been made, the ACP will be forwarded to the ASA(FM&C) in the form of a Cost Analysis Brief (CAB). When this is approved by the ASA(FM&C) it becomes the ACP and can be used in the ASARC/DAB process. Under Option 1 the OSD CAIG analyst estimate will fulfill the statutory requirement for an independent estimate.

(b) Option 2. CRB Executive Secretary decides that the level of program risk and uncertainty warrant an independent Army review of portions, or all, of the Cost IPT estimate. This review will be tailored to fit the situation. Figure 4-19 below illustrates the options for ACAT ID programs.



- Criteria for Determining CRB IPT Options for ACAT ID Programs
  - Cost & Technical Uncertainties
  - Program Cost Growth
  - Program Changes
  - Program Schedule Delays
  - Data Availability
  - AMC Validator, CAIG Analyst, or CRBWG Member Comments and Concerns
  - Stage in Life Cycle
  - Others ...?

Figure 4-19. Options for ACAT ID Programs

(2) ACAT IC Programs. Since the OSD CAIG delegates most independent estimates for ACAT IC programs to the Army, the CEAC Co-chair will prepare an ICE to fulfill the statutory requirement. The CCA analyst will employ the best current professional practice for that task. When comparing two estimates they may incorporate in the ICE, with or without adjustment, specific portions of the Cost IPT estimate, if it has independently established that the portions included are valid.

(a) The decision to incorporate parts of the Cost IPT estimate shall be based on such evidence, as follows:

1) Current prices or realized costs;
2) Cost incurred on similar programs; or
3) A verification based on experience that the methods and data used in constructing the portion accepted are reasonable.

(b) The ICE analyst will document the reasons for incorporation in its estimate of any portion of the Cost IPT estimate.

d. Preparation of the recommended ACP. The Cost/CRB IPT Co-chairs will prepare the recommended ACP. In situations where there is one estimate (ACAT ID, Option 1) the Cost/CRB IPT document the Cost IPT estimate in preparing the recommended ACP. In situations where there are two estimates (ACAT ID, Option 2, and ACAT IC) the Cost/CRB IPT will reconcile the two estimate and develop a single recommended ACP.

e. Cost/CRB IPT Issue Resolution Process:

One of the criteria for the success of the Cost IPT and CRB IPT processes is that reasoned disagreement leads to a better overall product. Any disagreement should be discussed and resolved within the Cost IPT/CRB IPT whenever possible. However, there will be those instances when the disagreement cannot be resolved within this IPT. When the disagreement cannot be resolved within the IPT, the Co-chairs should inform the PM of the problem and possible solution(s). At the same time the Staff Action officers (AO) should inform their supervisor. The PM and Staff AO's supervisor should then try to resolve the problem. If a resolution is not possible, the Staff AO's supervisor should inform the CRB principal of the problem and possible solution(s). The CRB principal and the PM should then try to resolve the problem. If the problem still cannot be resolved, the PM should inform the PEO and the CRB principal should inform the CRB Chairman. The PEO and CRB Chairman should then try to resolve the problem. If the problem still exists, the CRB Chairman should call a special CRB meeting where the problem can be presented with possible solution(s). In most instances the CRB should be able to adjudicate a solution. In the rare instance where this is not possible, the ASA(FM&C) will adjudicate. The ASA(FM&C) is the designate decision authority for cost and financial matters. When issues need to be resolved outside the Cost IPT, all affected parties should keep their respective chains of command informed of the issue, possible solution(s), and steps being taken to resolve the issue. Figure 4-20 illustrates the process.

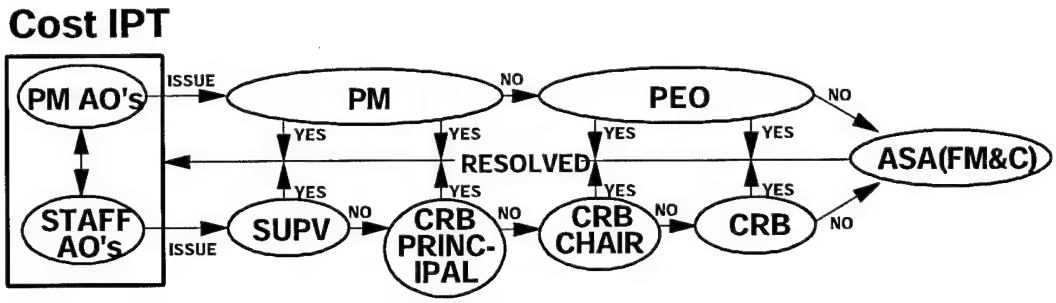


Figure 4-20. Issue Resolution Process

f. Documenting the ACP:

(1) The Cost/CRB IPT Co-chairs, with the assistance of the IPT members, will produce the CAB. The CAB is the responsibility of the Cost/CRB IPT Co-chairs. The documentation produced by the Cost/CRB IPT (in ACEIT) will be the basis for information contained in the CAB. Any remaining unresolved issues from the IPT process will be raised at the appropriate point in the CAB. The package is not complete until any changes that arise from the CRB briefing are adequately addressed. When this package is completed, the Co-chairs will sign the document and forward it to the ASA(FM&C) for approval of the CAB containing the ACP. The Co-chairs will maintain both paper and electronic copies of the approved CAB/ACP.

(2) The major sections of the CAB are as follows: Executive Summary, Introduction, System Overview (Description and Schedules), Methodology Summary, Army Cost Position (Ground Rules and Assumption, Cost Comparisons (if needed for unresolved issues), and Funding), and Appendices (References and Others, as needed).

(3) In addition to the developing the CAB, the Cost/CRB IPT Co-chairs, with the assistance of the IPT members, will brief the CRB on the results of their proceedings. The documentation produced by the Cost/CRB IPT (in ACEIT) will be the basis for information contained in the briefing. Any remaining unresolved issues from the IPT process will be raised at the appropriate point in the briefing. General format is as follows: Introduction of the Cost IPT members (and description of its proceedings), System Overview, Description of the Milestone Decision, System Quantities, Cost Element Summaries (prior & future), Cost Element Methodologies,

Funding Status, Issues, and Recommendations. For option 2 (ACAT ID) and ACAT IC programs a "Selected Cost Comparison" section will be added below Methodology sections. Both sections will address a proposed and an alternative response to the major issues in the program.

(4) The CRB Support Office (CRBSO) has numerous CABs and some CRB briefing packages on file. They can provide advice and assistance to the Co-chairs on these documents. As the proponent for the Army's cost risk and uncertainty analysis efforts, the CRBSO can provide advice and assistance for that portion of the CAB and CRB briefing packages.

4- 7. Army Systems Acquisition Review Council (ASARC)

a. The ASARC is the Army's senior-level review authority for ACAT I, ACAT II, and special programs. The ASARC is established to provide senior acquisition managers and functional principals the opportunity to review designated programs at formal milestones to determine a program or system's readiness to enter the next acquisition phase. They make recommendations to the AAE and the VCSA, who co-chairs the ASARC, for programs for which the AAE is the MDA. In addition to Milestone reviews, the ASARC may be convened at any time to review the status of a program. ACAT ID programs are subsequently reviewed by the DAB, where the MDA authority is the USD(A&T). The ACP is one critical decision document for the ASARC. In an effort to optimize the acquisition process, the Army has incorporated the principles of Integrated Product and Process Development (IPPD) into the ASARC process. At the core of the IPPD methodology are the IPTs. The Secretary of Defense has directed that the Department perform as many acquisition functions as possible, including oversight and review, using IPTs. These IPTs function in a spirit of teamwork with participants empowered and authorized, to the maximum extent possible, to make commitments for the organization or the functional area they represent. The IPTs themselves, are composed of representatives from all appropriate functional disciplines and the PMO, working together to build successful programs. They enable decision-makers to make the right decisions at the right time.

b. There are two IPT elements or levels supporting the PM throughout the ASARC process: (1) the ASARC IPT, and (2) the various Working-level Integrated Product Teams (WIPT). The ASARC IPT, established to support each program, performs the day-to-day work required to support the program throughout the acquisition process, to include those activities leading to a successful milestone decision.

c. ASARC Meeting

(1) An objective of the DoD Acquisition Streamlining procedures is to reduce the number of major program reviews; therefore, the MILDEP Review, concentrating on issues resolvable by the Army, will be the key Army review for ACAT ID programs. Formal ASARC meetings for ACAT ID programs will be held only if issues remain unresolved after the MILDEP Review.

(2) Attendance - The ASARC is composed of staff officials and commanders listed in Table 4-1. The ASARC Executive Secretary has responsibility for preparing the attendee list and the subsequent notification of all three star equivalent attendees. The PM and the DASC will provide the ASARC Executive Secretary a recommended attendance list based on the issues remaining at the conclusion of the MILDEP Review. The DASC will advise ASARC IPT members of the approved attendance list and ensure that the Principals below the three star level are notified.

Table 4-1. ASARC Membership

Vice Chief of Staff of the Army - **Co-Chairman**
Army Acquisition Executive* - **Co-Chairman**
Deputy Under Secretary of the Army (Operations Research)
Deputy Under Secretary of the Army (International Affairs)
Assistant Secretary of the Army (Financial Management)
Assistant Secretary of the Army (Research, Development, and Acquisition)*
Assistant Secretary of the Army (Installations, Logistics, and Environment)
Assistant Secretary of the Army (Manpower and Reserve Affairs)
Commanding General, Army Materiel Command
Commanding General, Training and Doctrine Command
Office of the General Counsel
Office of the Inspector General
Director, Information Systems for Command, Control, Communications, and Computers
Deputy Chief of Staff for Logistics
Deputy Chief of Staff for Operations and Plans
Deputy Chief of Staff for Personnel
Deputy Chief of Staff for Intelligence
Chief, Army Reserve
Chief, National Guard Bureau
Chief, Legislative Liaison
Military Deputy to ASA(RDA)
Director, Program Analysis and Evaluation
Director, U.S. Army Cost and Economic Analysis Center
Commanding General, Operational Test and Evaluation Command

Additional Members as Required
Chief of Engineers
The Surgeon General
CG, Military Traffic Management Command
CG, U.S. Army Space and Strategic Defense Command
Commander, U.S. Army Safety Center
Chief of Public Affairs
* Normally same person

(3) Agenda - Provided below is a typical agenda for the ASARC Review.

Item	Presenter	Time
Introduction	PEO	5 min
User Briefing	TSM	20 min
Developer Briefing	PM	30 min
Operational Effectiveness	OPTEC*	10 min
Affordability	PAED	10 min

Discussion	All	40 min
Summary of Decision	AAE/VCSA	5 min
Total		120 min

* If there are no test issues, the PM may brief this portion of the presentation

(4) Preparations - The final MIPS should answer all questions and identify the issues needing resolution by the ASARC. The ASARC briefing presentation should be prepared based on the information/data included in the MIPS. Background on all areas to be briefed in the ASARC - user, developer, tester, affordability - are contained in the MIPS. Some PMs may choose to include the ASARC briefing slides with the MIPS, thus having a single document/package for the ASARC Principals to review. The overall briefing package should include information on the topics/areas indicated below:

(a) The User briefing should focus on issues related to system requirements and should provide a validation of the requirement. Discussion of the threat must be included in order to identify those current projected enemy capabilities that drive the requirement or affect its ability to operate in the threat environment. At a MS III, certification is required that the forces will be prepared to accept and operate the system when fielded.

(b) The Developer briefing should include an update of accomplishments to date and compliance with previous directions; primarily a description of the issues related to alternatives for the future of the program. The briefing must also address acquisition strategy, schedule, current and future Exit Criteria, and cost. Schedule issues and associated risks must be discussed.

(c) The OPTEC briefing should present the results of required testing and must indicate if the system is operationally effective and suitable (if no test issues exist, the PM may cover testing results in the developer part of the briefing).

(d) The DPAE will brief the Affordability Assessment, which uses the Army Cost Position as the basis.

(e) The ASARC IPT Facilitator/DASC will present any unresolved issues and the Army Staff's Risk Assessment.

d. The Final ASARC IPT meeting is chaired by the VDISC[4] or the ASARDA Deputy for Systems Management. The purpose of the meeting is to determine if the program is ready to proceed to the MILDEP Review, and to review the MIPS and the ASARC Briefing. The goal of this final IPT meeting is to ensure that there are no open issues and no non-concurrences going into the MILDEP review. If this is not the case, the ASARC IPT will identify any remaining issues which require guidance or resolution at the MILDEP review.

(1) Attendance - This Final ASARC IPT meeting will normally be attended by the PEO, PM, all ASARC IPT members, and any staff principals that might be involved in issue discussion and resolution. ASARC IPT members will determine if their staff principal should attend and advise the PM and DASC accordingly. This should only be necessary if the office has an unresolved issue to be briefed and the principal's representation is needed to discuss and resolve the open issue. If the staff principal does not attend, the ASARC IPT member should be prepared to confirm the principal's concurrence with the contents of the MIPS.

(2) Agenda - The typical agenda should include a run-through of the proposed briefing slides by the briefers. Where there are issues which require a staff principal to attend, more time may be allocated to the discussion period. Briefers should present only the information required to support the decisions requested. It is important that all remaining issues are accorded a fair hearing and every effort made to reach resolution prior to the MILDEP Review. A typical Agenda is provided below:

Item	Presenter	Time
Introduction	PEO	5 min
User Briefing	TSM	20 min
Developer Briefing	PM	30 min
Operational Effectiveness	OPTEC	10 min
Affordability	PAED	10 min
ASARC IPT Memo	DASC	20 min
Discussion	All	20 min
Summary of Decision	Chairman	5 min
Total		120 min

(3) Preparations - It is the responsibility of the PM and the DASC to make arrangements for the meeting to include selecting the date, reserving a room and notifying attendees. It should be held 4-5 days before the scheduled brief to the MILDEP. The SARD, DISC4, and ASARC briefing rooms are all adequate for this purpose.

(4) Outcomes - It is important to make every effort to conclude this meeting with no unresolved issues. It is the responsibility of the VDISC[4] or the ASARDA Deputy for Systems Management to determine if the program is ready for the MILDEP review. He also decides whether or not to recommend a "Paper ASARC to the MILDEP. The PM will prepare a recommended attendance list for the ASARC based on the issues/outcomes of this meeting. In the event that issues still remain, the ASARC Review will be held. The Recommended Attendance List will be provided to the ASARC Executive Secretary before final invitations are issued.

4- 8. Cost Analysis Improvement Group (CAIG)

a. The goal is to provide the CAIG Chairman with a thorough understanding of the ACP. This includes the assumptions, data, and analysis made to support the ACP, which is based on the content in as described in the CARD (Section 4-2). The program overview includes acquisition strategy, technologies involved, inventory objectives, and operational concepts. The ACP can be a result of joint estimating or reconciliation. See section 4-6, Cost Review Board (CRB).

b. CAIG required documentation

(1) The DoD 5000 requires draft documentation of the POE, CCA, and ACP be provided to the CAIG no later than 45 calendar days before OIPT. For delegated programs, the draft documentation is due 45 calendar days before the ASARC's Milestone II or III review. To be determined (TBD) entries are unacceptable. The CEAC analyst must provide the CAIG with the final documentation of the updated POE, CCA, and ACP.

(2) The draft documentation of POE, CCA and ACP must contain the analyses to support the estimates. These include the specific assumptions, calculations, and supporting analyses in enough detail to allow the CAIG staff to replicate the estimates. The draft documentation is complete documentation.

(3) The final ACP will contain the changes made after the submission to the drafts. The CAIG must receive the final ACP at least 10 calendar days before a scheduled OIPT.

(4) Copies of the planned CAIG briefing and backup charts, and the briefing text (if it exists) should be submitted to the CAIG prior to the briefing.

c. CAIG briefing

(1) The briefing is scheduled to occur no later than 21 days prior to the OIPT. The format for CAIG briefings is tailored for each individual program. Ordinarily, within the general guidelines provided below, the CAIG, PM and CEAC action officers agree to a briefing format in advance. The format and content will depend on the issues. Typical elements for a CAIG briefing are:

(a) The POE, CCA (if prepared) and ACP. Note: The POE and ACP can be the same if they are prepared by a joint IPT and it is approved by the ASA(FM&C).

(b) Reconciliation of each of the major cost element variances among the POE, CCA, and ACP.

(c) Price escalation indices used.

(d) Summaries in base-year and then-year dollars.

(e) Proposed funding for each alternative.

(f) A year-by-year comparison of the ACP with the program in the latest POM and President's budget.

(2) A typical CAIG briefing will last no more than 2 hours.

4- 9. Selected Acquisition Report/Unit Cost Report (SAR/UCR) format

The SAR/UCR format provides for standard, comprehensive summary cost reporting for major acquisition programs. This format is based on the data in the SAR and the UCR (section 6, Defense Acquisition Executive Summary). These reports are required by law—the SAR by Title 10, U.S. Code, Section 2432 and the UCR by Title 10, U.S. Code, Section 2433. Figure 4-21 presents the SAR/UCR format that contains cost data required in the SAR and the UCR. These data aid in showing baselines for total program acquisition costs and unit cost reporting. In addition, they aid in determining the variances during the program's life cycle. The SAR/UCR format as designed provides a crosswalk from a cost estimate using the CES to the SAR baseline and Program Deviation Reports. The SAR baseline reflects the cost, schedule, and performance estimates of the program at the milestone decision point. For a pre-Milestone II report, the SAR reflects the current estimate of

cost, schedule, and performance parameters for the initial submission's "as of" date. The SAR requires costs in both base-year and then-year dollars.

SAR/UCR FORMAT

		Base-Year $	Then-Year $
I.	PROGRAM ACQUISITION		
a.	COST		
	Development (RDT&E)		N/A
	Procurement		N/A
	WBS 1		N/A
	WBS 2		N/A
	.		N/A
	.		N/A
	WBS n		N/A
	Total Flyaway		N/A
	Other Weapon System Cost		N/A
	Peculiar Support Equipment		N/A
	Initial Spares		N/A
	Construction (MILCON)		N/A
	TOTAL (FY XX base-year $)		N/A
	Escalation (total dollars)		
	Development (RDT&E)	N/A	
	Procurement	N/A	
	Construction (MILCON)	N/A	
	TOTAL (then-year $)	N/A	
b.	QUANTITIES		
	Development (RDT&E)*		
	Procurement		
	Total		

			Base-Year $	Then-Year $
II.	PROGRAM ACQUISITION UNIT COST SUMMARY (then-year $)			
Program Acquisition				
(1)	Cost (total then-year $)		N/A	
(2)	Quantity (total)			
(3)	Unit Cost ((1)÷(2))		N/A	

NOTE: * Must be "fully configured" for operational use to be counted.

Figure 4-21. SAR/UCR Format

SAR/UCR FORMAT

III. OPERATING AND SUPPORT COSTS
(Milestone II and later, only)

a.

Average Annual Cost Per Unit of Measure (elements approved at Milestone II) Example:	Base-Year $	Then-Year $
Personnel		N/A
O&S Consumables		N/A
Direct Depot Maintenance		N/A
Sustaining Environment		N/A
Other Direct Costs		N/A
Indirect Costs		N/A
Total		N/A

b.

Contractor Support Costs (then-year $)	Current & Prior	BY 1	BY 2	Balance to Complete	Total
O&M					
Industrial Fund					

IV. COST/QUANTITY INFORMATION

a. First Unit Cost
b. Slope (%, B value)

c.

Tabular Data	FY 1	FY 2	---------	FY n	Total
Quantity					
Flyaway Cost (base-year $)					
Nonrecurring					
Recurring					
Plot Points (X-axis)					

Figure 4-21. SAR/UCR Format (Continued)

4-10. PPBES support analysis

a. The cost elements, as defined, provide an estimating structure that tracks directly to the budget reporting requirements. In general, the RDT&E-funded elements will normally roll into a specific project number. This assumes that any RDT&E needed to develop system-specific support equipment will be funded under the PM's project number. The PM, in turn, will fund the support equipment efforts. The procurement-

funded elements, as designed, directly map to the required P-Forms. This assumes the system's PM will buy all support equipment required for the system, with these costs appearing in the P-1 line.

b. Figure 4-22 presents the crosswalk between the cost elements and the RDT&E forms. Figure 4-23 presents the crosswalk between the cost elements and the procurement forms. Figure 4-24 provides the AR 100-XX perspective on procurement accounts for each appropriation.

COST ELEMENTS TO RDT&E FORMS

COST ELEMENTS		SYSTEM-SPECIFIC PROJECT NUMBER	OTHER PROJECT NUMBER
1.0	RDT&E FUNDED-ELEMENTS	$	
1.01	DEVELOPMENT ENGINEERING	*	
1.02	PRODUCIBILITY ENGINEERING AND PLANNING (PEP)	*	
1.03	DEVELOPMENT TOOLING	*	
1.04	PROTOTYPE MANUFACTURING	*	
1.05	SYSTEM ENGINEERING/PROGRAM MANAGEMENT	*	
1.06	SYSTEM TEST AND EVALUATION	*	
1.07	TRAINING	*	
1.08	DATA	*	
1.09	SUPPORT EQUIPMENT	*	
1.10	DEVELOPMENT FACILITIES	*	
1.11	OTHER RDT&E	*	

* All the RDT&E-funded elements are included in the 1.0 rollup. The detailed cost-estimating structure is provided to support the estimating process. Each RDT&E project is described by an Army Management Structure Code (AMSCO). In most cases, the first digit of the AMSCO identifies the major force program, the second digit identifies the budget activity, the third digit identifies the research category, and the fourth, fifth, and sixth digits identify a unique serial number. The first three elements are identified below.

Major Force Program	Budget Activity	Research Categories
1. Strategic	1. Basic Research	6.1 Basic Research
2. General-Purpose Forces	2. Applied Research	6.2 Applied Research
3. Intelligence, Communications, and Other Activities	3. Advanced Technology Development	6.3A Advanced Technology Development
	4. Demonstration and Validation	6.3B Demonstration and Validation
	5. Engineering and Manufacturing Development	6.4 Engineering and Manufacturing Development
6. Research and Development	6. Management Support	6.5 Management Support
7. Central Supply & Maintenance	7. Operational Systems Development	6.6 Operational Systems Development

Figure 4-22. Crosswalk from Cost Elements to RDT&E Forms

COST ELEMENTS TO PROCUREMENT FORMS

2.0 PROCUREMENT-FUNDED ELEMENTS

P-1 Line (FY 92 and beyond)*

2.02	RECURRING PRODUCTION
2.03	ENGINEERING CHANGES
2.04	SYSTEM ENGINEERING/PROGRAM MANAGEMENT
2.05	SYSTEM TEST AND EVALUATION, PRODUCTION
2.06	TRAINING
2.07	DATA
2.08	SUPPORT EQUIPMENT
2.09	OPERATIONAL/SITE ACTIVATION
2.10	FIELDING
2.101	INITIAL DEPOT-LEVEL REPARABLES (SPARES)**
2.102	INITIAL CONSUMABLES (REPAIR PARTS)**
2.103	INITIAL SUPPORT EQUIPMENT
2.104	TRANSPORTATION (EQUIPMENT TO UNIT)
2.105	NEW EQUIPMENT TRAINING (NET)
2.106	CONTRACTOR LOGISTICS SUPPORT
2.11	TRAINING AMMUNITION/MISSILES**
2.14	OTHER PROCUREMENT

Separate P-Form Line—Support Equipment and Facilities

2.01	NONRECURRING PRODUCTION
2.12	WAR RESERVE AMMUNITION/MISSILES**
2.13	MODIFICATIONS

NOTES:

* There are some commodity-specific forms (such as the P-5) that require a lower level of detail than required by the time-phased matrix. However, this level of detail is normally included in the cost estimate documentation.

** Normally this element of cost (while an element of the system's life cycle cost) will not be included in the P-1 line for the system.

Figure 4-23. Crosswalk from Cost Elements to Procurement Forms

AR 100-XX TOP-LEVEL PROCUREMENT APPROPRIATION DESCRIPTION

10000000	Aircraft Procurement, Army	20000000	Missile Procurement, Army
11000000	Aircraft	22000000	Other Missile
11100000	Fixed Wing	22100000	Surface to Air
11200000	Rotary	22200000	Air to Surface
12000000	Modification of Aircraft	22300000	Anti-Tank/Assault
13000000	Spares and Repair Parts	23000000	Modification
14000000	Support Equipment and Facilities	24000000	Spares and Repair Parts
		25000000	Support Equipment and Facilities
30000000	Procurement Weapons and Tracked Combat Vehicles, Army		
31000000	Tracked Combat Vehicles		
31100000	Tracked Combat Vehicles		
31200000	Modification		
31300000	Support Equipment and Facilities		
32000000	Weapons and Other Combat Vehicles		
32100000	Weapons and Other Combat Vehicles		
32200000	Modification		
32300000	Support Equipment and Facilities		
40000000	Procurement Ammunition, Army	50000000	Other Procurement, Army
41000000	Ammunition	51000000	Tactical and Support Vehicles
41100000	Special Ammunition	51100000	Tactical Vehicles
41300000	Small/Medium Caliber Ammunition	51200000	Nontactical Vehicles
41400000	Artillery Fuses	51300000	Modifications
41500000	Miscellaneous	51400000	Support Equipment and Facilities
42000000	Ammunition Production Base Support	52000000	Communications and Electronic Equipment
		53000000	Other Support Equipment

Figure 4-24. AR-100-XX Procurement Accounts

4-11. Contract summary analysis

The POE and CCA documentation should provide a track to the major elements of the program contracts. This track should support contract analysis and cost/schedule analysis. The key to this is the development of the program WBS. This manual does not present a format because there is no specific or generic format that applies.

CHAPTER 5 - MATERIEL SYSTEMS SPECIAL TOPICS

5- 1. Introduction

This chapter provides an overview of special topics on materiel systems life cycle costing.

5- 2. Unit cost definitions

The definitions for the seven key cost terms from DoD 5000.4-M are shown in appendix L. Figure 5-1 presents the new cost elements (appendix E) crosswalked to the DoD 5000.4-M terms. Also, the figure presents the crosswalk to the Unit Cost Report (UCR) and the Selected Acquisition Report (SAR) definitions.

5- 3. Analysis of Alternatives (AOA)

a. The Cost and Operational Effectiveness Analysis (COEA) is the predecessor of the AOA. An AOA shall be prepared and considered at appropriate milestone decision reviews of ACAT I programs, beginning with program initiation (usually Milestone I). For ACAT IA programs, an AOA shall be prepared by the Procurement Systems Analyst for consideration at Milestone 0. These analyses are intended to:

(1) Aid and document decision making by illuminating the relative advantages and disadvantages of the alternatives being considered. Show the sensitivity of each alternative to possible changes in key assumptions (e.g., threat) or variables (e.g., selected performance capabilities). Where appropriate, include discussion of interoperability and commonality of components/systems that are similar in function to other DoD Component programs or Allied programs. The analysis shall aid decision makers in judging whether or not any of the proposed alternatives to an existing system offer sufficient military and/or economic benefit to be worth the cost. There shall be a clear linkage between the AOA, system requirements, and system evaluation measures of effectiveness.

(2) Foster joint ownership and afford a better understanding of subsequent decisions by early identification and discussion of reasonable alternatives among decision-makers and staffs at all levels. The analysis is intended to be quantitatively based, producing discussion on key assumptions and variables.

b. The DoD Component (or Principal Staff Assistant (PSA) for ACAT IA programs) responsible for the mission area in which a deficiency or opportunity has been identified normally prepares the AOA.

(1) The DoD Component Head (or PSA for ACAT IA programs), or as delegated, but not the Program Manager (PM), is responsible for determining the independent activity responsible for preparing the analysis.

(2) The lead DoD Component for a joint program is responsible for ensuring that a comprehensive analysis is prepared for a joint program. If the single analysis is to be supplemented by individual DoD Component developed analyses, the lead DoD Component shall ensure that the assumptions and methodologies used are consistent across the analyses.

(3) For ACAT ID and ACAT IAM programs, the DoD Component Head or designated official shall ensure coordination with the Under Secretary of Defense (Acquisition and Technology)

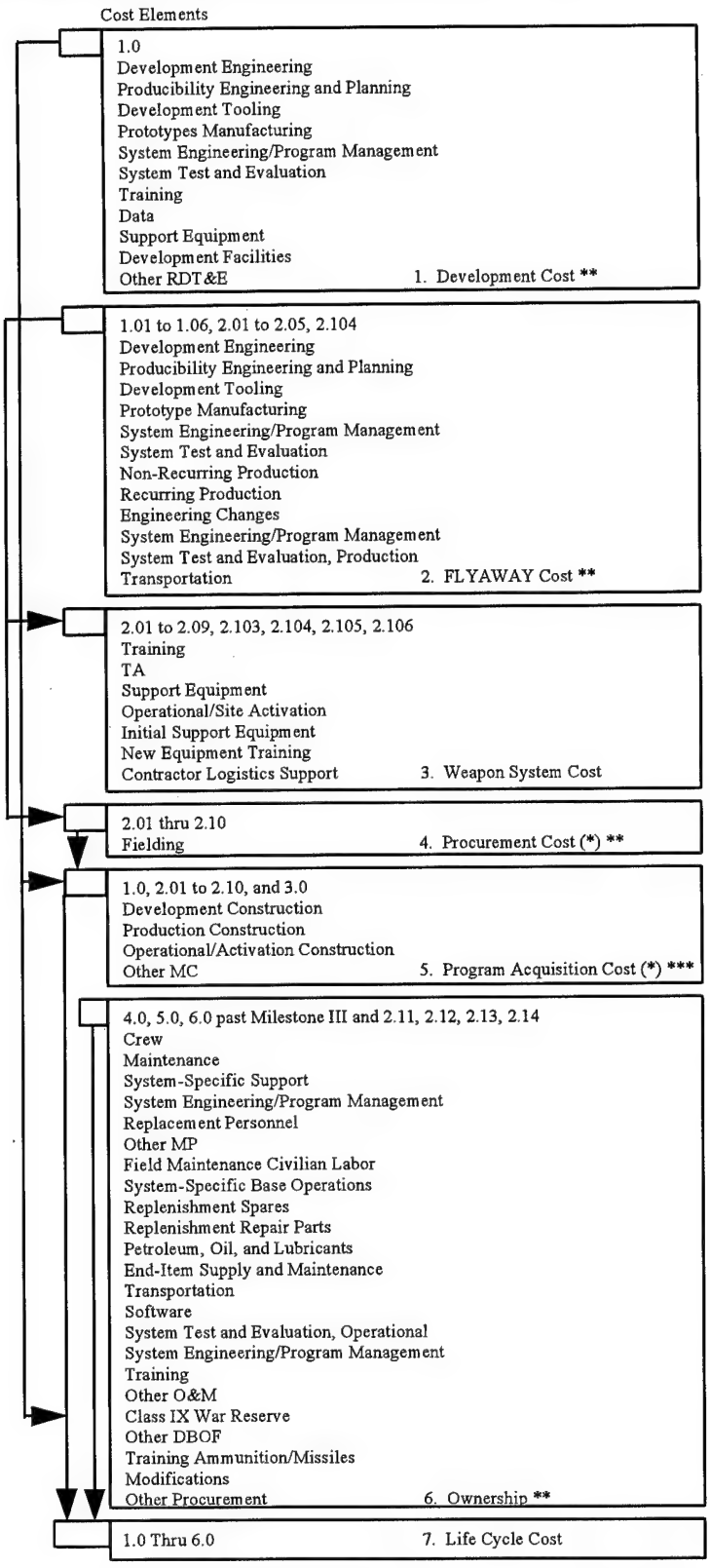


Figure 5-1. Crosswalk from Cost Elements to Unit Costs

(USD(A&T)) or Assistant Secretary of Defense (Command, Control, Communications and Intelligence) (ASD(C3I)) staff, the Joint Staff (or PSA) staff, the DOT&E staff, and the Director, Program Analysis & Evaluation (PA&E) staff takes place early in the development of the alternatives analysis. The staffs can make valuable contributions by ensuring that the full range of alternatives is considered; organizational and operational plans are developed with input from the Commanders in Chief of the Unified Commands and are consistent with U.S. military strategy; and joint-service issues, such as interoperability, security, and common use, are addressed. To form the basis for development of an analysis plan, the Director, PA&E shall prepare guidance for the AOA in coordination with the offices listed above. This guidance shall be issued by USD(A&T) or ASD(C3I).

c. Normally, the DoD Component completes the analysis for ACAT I programs and documents its findings in preparation for a program initiation decision (usually Milestone (I). The Milestone Decision Authority (MDA) may direct updates to the analysis for subsequent decision points, if conditions warrant. For example, an AOA may be useful in examining cost performance trades at Milestone II. An AOA is unlikely to be required for Milestone III, unless the program or circumstances (e.g., threat, alliances, operating areas, technology) have changed significantly. If the MDA determines that an AOA is required for ACAT IA programs after Milestone 0, the PM shall incorporate the analysis into the cost/benefit element structure and process described in 5000.2-R Paragraph 3.5.1.

d. A frequent focus of cost effectiveness analysis is the integration, or combination of cost and effectiveness results. There is no standard approach or single methodology for comparing cost and effectiveness to identify preferred alternatives. Rather, judgments about the relative importance of threats, needs, and tactics are important to the final decision. Cost effectiveness analysis can aid the decision process by providing a strong analytical framework. This framework provides a basis for ranking alternatives, identifying issues, highlighting implications of individual alternatives, and identifying variables that drive results. In this regard, cost effectiveness analysis should compare alternatives in the following context:

(1) On the basis of either equal cost or equal effectiveness.

(2) Identifying absolute values for measures of cost and effectiveness.

(3) Using cost effectiveness ratios or weighted measures carefully. The analyst should clearly explain their use such that the decision maker can interpret the results properly. The analyst should use ratios or weighted measures only with absolute values for cost and effectiveness measures.

(4) Identifying dominating relationships.

(5) Determining at what threshold results occur or change.

(6) Highlighting factors that determine relative ranking of alternatives.

5- 4. Unit cost, Army Working Capital Fund (AWCF), and surcharge

a. The total cost-per-output, or unit cost, concept entails that all costs incurred within a defined unit cost activity should be related to the output of that activity. This concept supports mission budgeting, mission-focused managing, and measuring the work performed in each unit cost activity. Cost that cannot be identified directly to a product or service can be formulated based on allocation methodologies appropriate for the unit cost activity. This approach has the advantage of encouraging DoD managers to look at all costs, including indirect costs plus the G&A costs, in terms of the output of their business activity (vice the entity itself). Unit costs, once properly mapped and verified, thus have the potential for communicating commonly accepted resource requirements, and are a tool to manage, to measure work performance, and to use as the basis for variance

analysis. Further, where unit costs are indeed accurate and timely, the concept helps earlier managerial intervention when cost-to-output goals are not achieved.

b. AWCF combines existing commercial or business operations into a single revolving, or business management, fund. The Army's initial business areas were in revolving funds, but future business areas will include activities from other than revolving funds. Setting up the AWCF does not change any previous organizational reporting structure or command authority relationship. Combining business activities under a single Treasury Code allows consolidation of cash management, while functional and cost management responsibilities remain with the Military Departments and Defense Agencies. Prices for goods and services produced in a component's business area remain the responsibility of that component and are set on a break-even basis over the long term. Profits, if they occur, are returned to customers through lower rates in later years. Losses, if they occur, are recouped through increased rates in later years.

c. AWCF was perceived as the ideal vehicle by which total mission budgeting could be accomplished through revolving fund principles. Business-type cost accounting systems were already being used in the original AWCF business areas and had the potential to be expanded to recognize both operating costs and capital (amortized) costs. Further, by operating under the premise that directly funded operating forces—the customer, such as Army divisions, Air Force wings, and Navy carrier groups—place demands on AWCF business areas through requisitions and job orders, the provider support infrastructure would be indirectly funded to the level of their sales. Note that there is no direct funding of the provider business areas.

d. A goal of the AWCF is to balance total revenues with total net operating costs. Net operating costs also include all gains and losses on inventories, capitalization, and transfers to reutilization and marketing. Total costs will not include requirements funded by appropriations such as war reserve appropriated amounts. The standard price of items will include a surcharge to cover logistics operations costs. Logistics operations costs represent the total cost of operations for a business area. These costs include integrated materiel management, supply depot operations, and second-destination transportation. Integrated materiel management primarily includes supply management costs, for example, inventory management, procurement, maintenance management, and G&A expenses. Supply depot operations include those costs to receive, ship, store, and preserve the inventory. Second-destination transportation includes those costs to move equipment to and from depots and field units. All AWCF sales will include applicable surcharges, including direct deliveries from contractors, commercial items, nonstandard items, manufacturer's part numbered items, and other items without a standard price. The Office of the DoD Comptroller will approve all surcharges, including any special local surcharges.

5- 5. Interface with integrated logistics support (ILS) and logistics impact analysis (LIA)

a. ILS and LIAs are crucial for effective system operations after fielding. ILS is a key step in the development of a system.

b. Early in the acquisition process, the developer must define the logistics requirements. Also, the developer must emphasize ILS comparable to cost, schedule, and performance in tradeoff decisions. ILS decisions apply to all acquisition programs, including nondevelopment item (NDI), as well as development programs, both major and non-major.

5- 6. Interface with program baseline

a. Baselining captures the program, in detail, for any given phase of the program. The baseline shall embody the cost, schedule, and performance part of the program.

(1) The concept baseline, approved at Milestone I, shall apply to the effort in Phase I, Demonstration and Validation.

(2) The development baseline, approved at Milestone II, shall apply to the effort in Phase II, Engineering and Manufacturing Development.

(3) The production baseline, approved at Milestone III, shall apply to the effort in Phase III, Production and Deployment.

b. Each baseline will contain goals for key cost, schedule, and performance parameters to include supportability. Normally for each goal, a minimum acceptable threshold exists. The thresholds set deviation limits that the program manager may not trade off. DoD 5000.2-R requires acquisition program baselining and deviation reporting for all ACATs.

5- 7. Financial analysis

Financial analysis is the process of analyzing financial performance through various analytical approaches and techniques. In the Financial Analysis Primer (appendix M), financial analysis is defined as an assessment of a company's past, present, and projected future financial condition, with the goal of evaluating its financial ability to perform. The Financial Analysis Primer is designed for managers and analysts who are interested in financial analysis. The primer is not intended to provide detailed "how to" instructions. Instead, it provides a discussion of the importance of financial analysis to the Army and various approaches to its accomplishment.

5- 8. Operating and Support Management Information System (OSMIS)

a. The Army developed OSMIS to provide a centralized data base for O&S information on fielded materiel systems. OSMIS had its origin in a 1974 initiative from OSD to improve the visibility and control over materiel systems' O&S costs. The initiative called for the Services to develop a management information system to report the actual O&S costs for fielded materiel systems. OSMIS is the Army's response to that requirement.

b. Each fiscal year, CEAC produces in-depth reports on materiel systems' costs captured in the OSMIS data base. The reports are titled:

Volume I - Aviation Systems

Volume II - Combat Systems

Volume III - Artillery/Missile Systems

Volume IV - Tactical Systems

Volume V - Engineer/Construction Systems

Volume VI - Communications/Electronics Systems

c. These volumes provide reference data for each materiel system which supports the following analyses:

(1) Summarized cost comparisons for weapon systems;

(2) Annual MACOM costs;

(3) Weapon system MACOM OPTEMPOS;

(4) Annual weapon system depot civilian and military labor costs in comparison to Aviation Intermediate Maintenance (AVIM), Direct Support/General Support (DS/GS), and Directorate of Logistics (DOL) military and civilian labor costs;

(5) Average cost to rebuild/overhaul and repair by weapon/materiel system;

(6) Specific national stock number (NSN) cost driver detail at the Total Army level for consumable and reparable; and

(7) Historical Class IX reparable and consumable consumption rates (quantity per hour or per mile).

(8) Training Resource Model OPTEMPO rates to include change in logistics and supply policy for budget development.

d. MACOMs included in these reports are: Forces Command (FORSCOM), U.S. Army, Europe (USAREUR), Eighth U.S. Army (EUSA), U.S. Army, South (USARSO), Training and Doctrine Command (TRADOC), U.S. Army Pacific Command (USARPAC), Army National Guard (ARNG), U.S. Army Reserve (USAR), and U.S. Army Special Operations Command (USASOC).

5- 9. Sunk costs

a. Sunk costs are all past expenditures or irrevocably committed funds related to a given cost estimate. Analysts can express sunk costs in either current or constant dollars, but it must be explicitly stated as to what type of dollars they are. Normally, analysts should not use sunk costs in alternatives for decision making as they reflect previous choices rather than current choices. However, in some cost effectiveness analyses, analysts may use sunk costs in alternatives that consider the value of existing assets versus buying new assets. Sunk costs are an important basis for estimating future trends and are required when documenting the program LCC. As a general practice, analysts estimate costs without regard for which portions, if any, are programmed, budgeted, appropriated, obligated, committed, invoiced, or expended. In life cycle costing, cost analysts must identify all sunk costs and should identify them by cost element.

b. To help tracking to the PPBES process, analysts should separate sunk costs in the estimate in two groupings. The first is the year preceding the current year. Prior year (PY) is the name of this first grouping. The second is a total of all the previous years exclusive of the PY.

c. Funding policy changes have resulted in new cost element definitions. As a result, formerly reported sunk costs do not conform with the new CES used in this manual. The new CES contains special cost elements for sunk cost only. This allows analysts to incorporate directly estimates completed under previous guidance into the new CES. These new cost elements are in the procurement and O&M "other" cost elements (see figure 5-2).

Cost Element	
2.0	**PROCUREMENT-FUNDED ELEMENTS**
2.14	Other Procurement
2.141	Replenishment Spares (sunk prior to DMRD 971 funding changes). This element includes all other replenishment spares that are not contained in any of the other procurement funded cost elements.
2.142	War Reserve Spares (sunk prior to DMRD 971 funding changes). This element includes all other war reserve spares that are not contained in any of the other procurement funded cost elements.
2.143	Depot Maintenance Materiel (sunk prior to DMRD 971 funding changes). This element includes all other depot maintenance materiel that are not contained in any of the other procurement funded cost elements.
2.144	Other.
5.0	**OPERATIONS AND MAINTENANCE-FUNDED ELEMENTS**
5.12	Other O&M.
5.121	Initial Repair Parts (sunk prior to DMRD 971 funding changes). This element includes all other initial repair parts that are not contained in any of the other O&M funded cost elements.
5.122	War Reserve Repair Parts (sunk prior to DMRD 971 funding changes). This element includes all other war reserve repair parts that are not contained in any of the other O&M funded cost elements.
5.123	Other.

Figure 5-2. Special Sunk Cost Categories

CHAPTER 6 - ENVIRONMENTAL COSTING

6- 1. Introduction

The magnitude of the Environmental, Safety and Health (ESH) portion of weapon system life cycle costs is significant. One analysis has estimated that 80% of the costs to handle, treat and dispose of wastes within DoD facilities and installations are directly related to weapon system operations, maintenance and disposal. Another study has estimated that every weapon system dollar spent to acquire hazardous materials will require eighty (80) dollars over the life cycle to manage, control, and ultimately dispose of the hazardous material. Environmental costs are potentially a significant cost when viewed over the life cycle of a system. For this reason, it is especially important that environmental costs be included in the acquisition costs of a system. Therefore, all LCCE must address environment costs.

6- 2. Background

a. In November 1994, the General Accounting Office published a report on the status of DoD's efforts at pollution prevention. Cost estimating and cost analysis were cited in that report as follows:

"DoD has not issued guidance for performing life-cycle costs analyses for comparing the costs of toxic chemicals with less toxic chemicals. As a result, purchasing decisions are not always environmentally sound or cost effective because they are generally based on the initial price of the material. Life cycle costs associated with environmental considerations, such as the cost to dispose of hazardous waste, are not considered and can total more than the purchase price. "

b. Environmental costing issues, such as restoration and cleanup costs within the DoD, have increased dramatically over the last few years. This is due, in large part, to stronger and more stringent environmental, legislative, and regulatory requirements that have made the identification and estimation of environmental costs for programs more critical than ever. Present environmental costing guidance can generally be summarized under one of three main themes:

(1) Timing of Environmental Costing Activities. Almost all environmental guidance indicates that planning should begin as early as possible. DoD 5000.2-R refers to the Programmatic Environmental Safety Health Evaluation (PESHE) for integrating environmental considerations into the acquisition strategy at the earliest possible time. It is well recognized that the greatest cost benefit occurs when the correct decisions are made early enough in the acquisition life cycle to avoid rework or post fielding modifications. For this reason, Program Office Estimates (POE's) are required to include all relevant environmental costs as early as Milestone I.

(2) Life Cycle Cost Alternatives. It is imperative that program decisions be based upon the program life cycle cost and not solely on the program acquisition cost. Therefore, the life cycle cost becomes the measure of merit for examining environmental alternatives. From an environmental perspective, that means that all alternative direct and indirect costs must be weighed for acquisition, manufacturing, supply use, storage inventory control, treatment, recycling, emission control, training, work place safety, labeling, hazard assessment, engineering controls, medical monitoring, regulatory overhead, spill contingency, disposal, remedial actions, liability, etc.

(3) Inclusion of ESH Costs in POEs. Recent guidance from the DoD Cost Analysis Improvement Group (CAIG) states that environmental costs should be included in program cost estimates. This guidance stresses demilitarization and disposal as well as environmental costs that may arise in any major element of the POE cost estimating or work breakdown structure (CES/WBS) and includes costs arising from

requirements for pollution prevention, compliance, conservation, hazardous waste management and disposal, conversion, and site cleanup.

c. DoD 5000.2-R, Section 4.3.7, requires that ESH be integrated into the systems engineering process that translates operational needs and requirements into a system solution, including design, manufacturing, test and evaluation, and support processes and products. These recent changes to policy propose that, where the environmental costs cannot be separately broken out, the cost estimate should present evidence that the environmental costs are adequately accounted for elsewhere in the estimate.

6- 3. Environmental Cost Methods and Work Breakdown Structure (WBS)

a. One of the challenges facing the cost estimator is how to integrate the ESH costs into a program specific work breakdown structure. Guidelines and costing preferences have ranged from costing the ESH impact wherever it is appropriate in the WBS, to costing the ESH as a single entry at each acquisition phase to obtain the total ESH cost. One popular recommendation has been to map the ESH breakdown structure to the program work breakdown structure, beginning at the subsystem level and moving progressively to lower levels as the system becomes better defined during the acquisition cycle. Based upon the data normally available during the Engineering and Manufacturing Development Phase, the cost analyst should be able to collect costs at WBS level five or six for components that have potential ESH impact (such as a solid rocket motor). Although this is the preferred approach, one drawback to the WBS approach is that it may result in some rather large cost spreadsheets. For analysts choosing to cost ESH in this manner, a matrix mapping the ESH breakdown for each CES is provided in Table 6.1 at the end of this chapter.

b. Another recommendation is to cost the ESH impact as a single entry at each major acquisition phase of the POE. Analysts wishing to use this methodology to estimate ESH costs can find a sample format in Table 6.2 which is also located at the end of this chapter. Regardless of the approach used, keep in mind two general ESH costing objectives:

(1) First, ensure that all environmental costs are included in the program estimate.

(2) Second, provide visibility to the environmental costs such that acquisition and supporting decisions can be based upon them.

c. In summary, what to cost and how much detail to place in the cost estimate will depend upon an accurate assessment of the program and the CARD. If the ESH risk for the program is significant over 10% of the life cycle costs and has the potential for environmentally catastrophic events or results in significant amounts of hazardous materials, etc. then a significant amount of cost analysis will be necessary. A realistic CARD is the final driver in determining the specific cost estimating requirements since all program cost estimates must align with the information in the CARD. If a cost analyst discovers, during the assessment, that a program has potential for significant ESH risk or ESH costs, then it is appropriate to provide that information to the authors of the CARD for amendment. This assures that the CARD accurately reflects the ESH risks of the program and that the cost estimate addresses the costing requirements.

6- 4. Environmental Cost Estimating Tools

a. This section lists several tools the cost analyst may find useful for ensuring that all environmental costs are included in the Program Office Estimate (POE). Most current environmental cost models estimate the costs of environmental restoration and corrective measures quite well, but they are greatly lacking in their ability to estimate the cost of environmental activities during the acquisition and support phases. Generally, the current cost tools were developed for a specific application and, as a rule, do not meet the diversity required for

estimating the environmental costs of weapon systems. Most ESH cost estimating tools are designed for PC operation and require specific technical expertise. If you are interested in any of the models listed below contract CEAC's Cost Review Board Support Office at (703) 681-3330.

(1) The Funding Estimator Tool for Weapon System Pollution Prevention. This tool was designed to be used by the program manager to develop strawman funding requirements for pollution prevention.

(2) The Hazardous Materials Life Cycle Cost Estimator (HAZMAT) Model. The Human Systems Center at Brooks AFB has also developed the Hazardous Materials Life Cycle Cost Estimator (HAZMAT) Model. The HAZMAT was developed to support DoD pollution prevention initiatives conducted throughout a weapon system's life cycle. It is designed to perform cost trade-off studies between currently used materials and other, less hazardous, materials. HAZMAT produces estimates only at the manufacturing and maintenance process level and is best suited to conduct process level trade-off studies. One of its limitations is that the model requires substance and process-level data to estimate costs in the early acquisition phases.

(c) The Remedial Action Cost Engineering and Requirements (RACER)/ Environmental Cost Engineering System (ENVEST) Model. This system may be used to estimate activities for on-going programs. The RACER-ENVEST model is designed to produce objective, consistent, and reasonably accurate estimates in the early phases of environmental remediation projects and progressively more detailed and defensible estimates as the project matures. The RACER is a Windows-based environmental cost estimating system that will estimate costs for studies, remedial design, remedial action and related site work. ENVEST is a parametric estimating model and includes cost models for technologies associated with landfills, storage tanks, spills, disposal and waste pits, low level radiation waste sites, and surface runoff..

6- 5. Environmental Cost Estimating Core Activities

a. There are several core activities that are imperative for good ESH cost estimating and analysis. Each of the activities described occur over multiple phases of the system life cycle. These core activities have been grouped into five categories.

(1) Participation. Participation activities are focused on involving the appropriate agencies in ESH matters at the appropriate level and phase of the system's acquisition. Participation by the appropriate agencies at the appropriate time is essential to define requirements, identify alternatives, select the best alternative and obtain the necessary consensus for implementation of the system. In system acquisition, it is often observed that establishing initial participation is the hardest part of continued involvement. Once the habits of participation are established and the benefits demonstrated to the participating activities, their participation will be easier to sustain. As the system design is being finalized and system specifications completed, the opportunities for the ESH Working Group (ESHWG) to make significant changes are limited. As a minimum, the following agencies should be participants:

(a) Participation by a cost analyst or financial management specialist in the ESHWG will enable the participants to more quickly identify the ESH cost issues that should be addressed in the program cost estimate. The cost analyst or financial management specialist will also provide the necessary expertise to perform some of the life cycle cost trade-offs that may be required later in the program. Early participation in the program will provide the cost analyst or financial management specialist familiarity with the program's history and the alternatives reviewed, during the decision process.

(b) Testing agency involvement is essential to ensure that the TEMP guidance both meets the needs of the developers and testers to comply with all statutory environmental standards.

(c) Logistics agencies need to become involved early in the acquisition process since the use of hazardous materials and ODC materials can impact support concepts.

(d) User agency involvement is essential. The Users will bear the bulk of environmental, safety, and health costs of the system. ESH issues that reflect operations and support concerns can often be solved at far less cost early in the acquisition life cycle.

(e) Environmental agencies such as the Army Environmental Center, the Industrial Ecology Center, and the US Army Corps of Engineers have substantial expertise and cost data, which can be useful for estimating environmental costs. Early involvement by these agencies often introduces innovative solutions to costly environmental issues.

(2) Planning. ESH planning must occur as an essential element of the overall acquisition strategy. Pollution prevention strategies are important considerations in the overall acquisition plan, such as life cycle cost, performance tradeoffs, risks, source selection procedures, budgeting and funding, test and evaluation, and logistic considerations. Other ESH in the acquisition strategy include: demilitarization and disposal, remediation, litigation and liability, ESH management, resource conservation, and compliance.

(a) DoD 5000.2-R requires that the acquisition strategy include a programmatic environmental, safety, and health evaluation (PESHE). The PM initiates the PESHE at the earliest possible time in support of a program initiation decision (usually Milestone I) and maintains an updated evaluation throughout the life-cycle of the program. The PESHE describes the PM's strategy for meeting ESH requirements, establishes responsibilities, and identifies how progress will be tracked.

(b) The Defense Federal Acquisition Regulation (DFAR) also states that the acquisition plan shall ensure compliance with DoDD 4210.15, Hazardous Material Pollution Prevention.

(3) Costing. Costing refers to ESH cost estimating as well as to the analysis of historical costs necessary for decision making. ESH costing activities occurs during each phase of acquisition. The cost estimating may be associated with other trade-off studies, where only costs sensitive to the trade-offs are addressed; or the cost estimating may be more comprehensive, such as in the development of a complete program cost estimate. DoD 5000.2-R requires that any hazardous materials be identified that may be encountered or generated during the development, manufacture, transportation, storage, operation, or disposal. The quantities of each and their associated life cycle costs are to be estimated. Five general topics are identified as highly relevant to environmental costing.

(a) *Cost Analysis Requirements Description (CARD).* The CARD is important to the ESH management of a program. It provides the environmental baseline from a costing perspective. The CARD cannot receive too much emphasis because all program cost estimates are required to be consistent with the CARD. For this reason, it is essential that the CARD explicitly identify all ESH requirements, goals, and directives. ESH professionals and cost estimators must work together to identify the full ESH content of the CARD.

(b) *The Program Office Estimate (POE).* The POE must include costs for ESH related activities, products, and services. DoD CAIG guidance specifically requires that the estimate encompass any significant ESH costs. Such costs may arise in any, or all, of the major segments of the estimate and stem from activities for pollution prevention, compliance, remediation, restoration , conservation, litigation, liability, added management or overhead costs, and/or demilitarization and disposal of the system. DoD 5000.2-R requires that all hazardous materials be identified that may be encountered or generated during the development, manufacture,

transportation, storage, operation, or disposal. The quantities of each should be estimated over the life of the system.

(c) *Cost Risk and Risk Management.*

1) Environmental cost risk is defined as the extent that a given technology alternative or process can be implemented without generating an intolerable level of hazardous materials or unacceptable environmental damage. In the environmental area, the potential for cost liability during the life of a system, including remediation and fines, may be difficult to quantify. Environmental cost risk may be determined using a methodology similar to that used for safety analysis where the likelihood of a mishap is combined with the consequences of a mishap to identify the safety risk. A similar approach appears to be a workable solution for estimating environmental cost risk.

2) Risk management is a large part of the PM's job. From an ESH perspective, the risk management system should include the results of contractor trade studies, material substitutes, elimination of certain regulated materials and environmental compliance during manufacturing. If extremely hazardous materials are used, a separate RMP may be required by the Environmental Protection Agency (EPA). Program offices may need to be concerned with at least two types of risk: (a) The contractor elects not to manufacture a component with a hazardous material and availability of the component is questionable, or (b) A substitute process or material is used. This may put the performance, durability or maintainability of the item at risk.

(d) *Cost as an Independent Variable (CAIV).* The ESH community supports CAIV for two reasons. First, CAIV places an increased emphasis on life cycle cost, thereby bringing increased attention to O&S costs where the majority of ESH costs reside. Secondly, the establishment of aggressive cost objectives means that ESH solutions or alternatives that result in lower life cycle costs will receive greater support than they have in the past. This may reverse practices that emphasize lower development and production costs at the expense of higher user and disposal costs. CAIV provides the opportunity for prepared analysis to demonstrate the benefits of ESH improvements and impact the decision processes.

(e) *AOA (AOAs).* The AOAs take the place of what was formerly referred to as the Cost and Operational Effectiveness Analysis (COEA). ESH professionals should provide inputs to the AOA. Pollution prevention considerations should be part of the assumptions, variables, and constraints, especially for the life cycle cost of each alternative. Any updates to the initial AOA should be sufficiently detailed to permit the identification of a preferred alternative and its cost. Cost estimates for AOAs should take into account gross estimates of investment and disposal costs. Most of the ESH costing associated with the AOA will focus on comparing life cycle costs for several alternatives, including those that use less hazardous materials.

(4) Requirements. The requirements documents, the Operational Requirements Document (ORD) and the Mission Need Statement (MNS) describes key boundary conditions that may impact on satisfying the need and the operational environments in which the mission is expected to be accomplished. It is appropriate in this section to address environmentally sensitive issues such as impact to the ozone from use of solid rocket motors. While there is no requirement in DoD 5000.2-R to address specific environmental requirements in the MNS or ORD, using commands are documenting ESH requirements such as "System must be maintainable using no ODCs". Additionally, ESH external requirements, such as Executive Orders and Public Laws, are levied upon the Service from outside the DoD. These requirements may significantly impact system environmental costs. Reacting to externally generated requirements is best accomplished by a team composed of program engineers, ESH professionals and cost analysts.

(5) ESH Engineering and Management. ESH engineering and management is a category of recurring activities that reviews ESH alternatives and monitors and reports on those that are implemented and all

documentation associated with federal compliance. Cost estimating supports this category of activities including modeling and measuring the cost merit of different alternatives. Subordinate topics of ESH engineering and management include:

(a) *Identification and Analysis of Hazardous Materials.*

1) This activity is the heart of a PMs ESH responsibility. PMs are charged with reducing the use of hazardous materials in all phases of weapon system development, from concept through disposal, and finding alternative materials or processes. A key elements in reviewing alternatives is a "could cost" analysis that includes both direct and indirect costs throughout of the life cycle. Each milestone review should contain an evaluation of hazardous materials and documentation of the program decisions for pollution prevention.

2) DoDD 4210.15 requires that any hazardous material decision be based upon economic analysis (EA) and considering all cost factors and intangible factors as applicable. EAs should continue throughout the acquisition cycle as better information becomes available.

(b) *Environmental Analysis and the National Environmental Policy Act (NEPA) Process.* The EA and NEPA processes address the environmental analysis that a program may have to perform to comply with federal requirements and includes the documentation of that analysis in a manner that complies with current DoD acquisition guidance.

1) DoD 5000.2-R, Section 4.3.7 requires PMs to implement NEPA, its implementing regulations, and appropriate Executive Orders (EO). When required, this analysis begins in Phase 0 and continues throughout each phase of the acquisition cycle, updating the information previously generated. The analysis feeds into the Program ESH Evaluation (PESHE) required by *Section 3.3.6 of DoD 5000.2-R.* (Prior to the revision of DoD 5000.2-R, the Programmatic Environmental Analysis (PEA) satisfied this requirement.) The PESHE is the roadmap or environmental plan that describes the status of documents required under Section 102 (2) (c) of NEPA and will include the cost, schedule, and performance impacts of all program environmental issues. Beyond the requirements for continuing ESH analysis, there are very few specifics regarding the content and format of life cycle cost analysis of ESH. Analysts should by guided by the basic principles of economics and informed judgment.

2) Prior to the revision of DoD 5000.2-R, requirements to document environmental analysis lay in Annex E of the Integrated Program summary. Most of those requirements now apply to the Single Acquisition Management Plan and answer such questions as:

- Are waivers necessary for the successful execution of the program?
- What is the potential for significant adverse ESH impacts associated with the decisions to be made during the next acquisition phase?
- How will the NEPA process be used to mitigate environmental risks?
- Is there a potential for adverse operational performance or readiness impacts associated with ESH laws, regulations, and EOs?
- What is the design approach for a clean environment?
- How will pollution free processes be used on the program?
- What is the program ESH support strategy?
- How is the program addressing safety, health hazard, and human factors domains?
- What hazardous materials management approach will the contractor use?

3) The Environmental Impact Analysis Process (EIAP) is a direct result of the National Environmental Policy Act (NEPA) of 1970 and the Council on Environmental Quality, 40 CFR, Parts 1500-1508 and serves two purposes. One purpose is to force federal agencies to assess the environmental impacts of their actions in order to make informed decisions. A second purpose is that it allows federal agencies to inform and include the public in the decision making process of federal actions that have environmental impact. Some programs, by virtue of design and performance characteristics, may require multiple EIAP documents. The cost analyst using EIAP documents is advised to check for multiple documents on large or complex programs.

(c) *Monitoring Contractor Activities.* DoD 5000.2-R requires that PMs establish a hazardous material management program to ensure that appropriate consideration is given to eliminating and reducing the use of hazardous materials rather than simply managing the pollution created. The selection, use, and disposal of hazardous materials will be evaluated and managed so that DoD incurs the lowest cost possible to protect human health and the environment. Where a hazardous material cannot be avoided, the PM will plan for later material replacement capability in the system design, if feasible and practical, and shall develop plans and procedures for identifying, minimizing, tracking storing, handling, and disposing of the hazardous material.

1) National Aerospace Standard 411 (NAS-411) is often used to satisfy the management requirement. NAS-411 includes requirements for a Hazardous Materials Management Program (HMMP) Plan and its associated reports. In each phase and in each contract, it is expected that the HMMP Plan will be updated and the reports continued. This process serves to focus the contractor's attention on hazardous materials. The reports will also enable the PM's shop to monitor the contractor's efforts.

2) Other methods for monitoring contractor environmental management are through the use of logistics support information. Logistics support information is typically an electronic database generated by the contractor as part of the design process. It may be referred to as Logistics Support Analysis Record (LSAR) data. The LSAR is one of the primary methods for recording important environmental information throughout the acquisition cycle as it provides a summary of all hazardous materials that are required to support the system or any component therein. Early identification of potential pollutants and hazardous materials can assist in implementing optimum prevention strategies. Reports generated from the electronic database can prove useful for cost estimates of hazardous materials and their associated storage and disposal costs.

3) Cost analysts may be involved in the monitoring of contractor activities in one of two ways. Initially the cost analyst will assist by providing estimates of the contractor's ESH costs to manage the government's hazardous materials program and to provide the plan and reports. Also, a cost analyst may be involved in refining life cycle cost estimates based upon contractor reports.

(d) *The ESH Procurement Action.* The program office and the prime contractor need to function as a team when addressing environmental and pollution prevention issues. Whether in the initial acquisition or performing major modifications to existing weapon systems, the same activities are used to form the government and contractor team. The Statement of Objectives (SOO) or Statement of Work (SOW), Request for Proposal (RFP), and source selection activities establish the requirements and expectations. Most of the activities involved in procurement have an impact on environmental cost and will provide valuable insight to the cost analyst.

1) A sound proposal, from an environmental management perspective, should, as a minimum, include:

- How the systems engineering process will be used to manage hazardous materials.

- A total LCCE of the ESH costs.
- Demonstrated flow down of ESH concerns to subcontractors and vendors.
- The ESH management activities in the Integrated Master Plan (IMP) or appropriate program schedules.

2) In source selection, cost estimating support may be required to evaluate the environmental costs presented by the contractor. The cost analyst should pay close attention to:

- Activities and costs anticipated during system support, training, demilitarization, and disposal.
- Identification of all activities associated with pollution prevention and hazardous materials and ensure that their costs are factored into unit costs or costs of the program
- Risk possibilities, consequences and estimates for remediation.

(e) *Program Technical Reviews.* Each phase of the acquisition cycle may have program technical reviews. Particular emphasis is placed on ensuring that adequate consideration has been given to logistics' support, software, test, and production constraints. Design reviews in the later stages of development are critical milestones for assessing the status of program ESH management. From a management perspective, the reviewers will compare pollution prevention accomplishments to those postulated in the Integrated Master Plan. These design reviews should include a review of pollution prevention metrics, drawings, and documents which define material content. Specific items of interest to the cost analyst may include other cost estimates, ESH related trade studies, and the contractor's approach to pollution prevention and hazardous materials management.

6- 6. Trends in Environmental Safety and Health

Since Acquisition Reform and Streamlining, the Department of Defense's weapon acquisition processes have continued to undergo changes and adjustments to many of their acquisition procedures. Increased reliance upon commercial equipment, reduced reliance upon specifications and standards, and increased ESH regulations are just a few processes undergoing changes. This section highlights ESH changes to cost management. Cost analysts may use this section of the Cost Manual for planning weapon system acquisition activities. However, you are cautioned to check with DA functional managers for the latest guidance as changes are occurring rapidly.

a. Demilitarization and Disposal (D&D).

(1) The area with the greatest potential for environmental cost impact is the emphasis and enforcement of the requirement to include demilitarization and disposal costs in life cycle cost estimates. Although the revised DoD 5000.2-R does not include a separate D&D phase, the emphasis on D&D costs remains high.

(2) It is important that the cost analyst distinguish between D&D costs and other ESH costs. D&D costs and ESH costs overlap considerably within the umbrella of total life cycle costs, especially when D&D costs occur due to environmental compliance or remediation requirements. Generally speaking, pollution prevention should be included in all phases of the weapon system life cycle, including D&D, while other ESH costs, such as ESH related management costs for health risk and environmental impact assessments, compliance plans, permits, reports, etc. are more appropriately addressed in the weapon system life cycle phases other than D&D.

b. Streamlined Acquisition Procedures. The area of streamlining is changing rapidly and new procedures are not as well documented as the PESHE changes or demilitarization and disposal costing. MIL-

STD-881B has been reduced to a guidance document only. That reduction may make it more difficult to compare costs between programs. As a result, decision makers will be challenged to make decisions with less information and less standardization than was previously available. The message to cost analysts remains clear...tailor your estimate as needed to fit the unique features of each system, but keep focused on the objectives.

c. Affirmative Acquisition. Affirmative acquisition, frequently called preferred acquisition, is the establishment of specific requirements for the purchase of environmentally preferred products and services. The purchase of recycled materials will be emphasized and contract awards will be evaluated based upon the objectives. Cost estimating techniques and source selection will need to address affirmative acquisition.

d. Contractor Overhead Management. The contractor's overhead represents a sizable portion of the cost of a government contract. Recent trends attempt to drive down overhead costs. Cost analysts need to remain aware that some contractors currently carry a portion of ESH activities as overhead. With more cost-plus contracts, contractors will be pressured to reduce overhead costs, including needed environmental activities. The ESH activities embedded in the overhead rate structure could be reduced in an effort to lower overhead rates. PMO's may want to consider overhead "should cost" analyses, to gain insight into the ESH costs that reside in

e. ISO 14000.

(1) International Organization of Standardization (ISO) 14000 is the umbrella of a set of environmental management standards being developed to bring worldwide focus to the environment. Subordinate standards will address labeling, auditing, and environmental assessments. One of the strongest points will be the disclosure requirements for companies desiring ISO 14000 certification. While there is general consensus that ISO 14000 can help companies identify and manage their environmental obligations, there is no assurance that certification will improve environmental performance.

(2) There are four reasons a corporation may seek ISO 14000 certification: decreased costs, market opportunities, pressure from the financial community and the public, and corporate image and community goodwill. ISO 14000 may have a positive impact on environmental costing if the companies who become certified are able to reduce their potential for increased environmental cost risk as a result of the standardization.

f. EO 12969 and EPCRA. Executive Order (EO) 12969 was released on 8 August 1995. The EO requires toxic release reporting for all federal acquisitions. This requirement is consistent with, and supports, the Emergency Planning and Community Right-To-Know Act (EPCRA). Executive order 12856 requires compliance with EPCRA while the Federal Facility Compliance Act also requires federal facilities and operations to comply with all environmental laws and regulations, including state requirements for reporting hazardous material spill and releases. Therefore, even if Congress repeals EPCRA, as it is trying to do, the states may still have this reporting requirement; otherwise, the requirement for reporting for federal acquisitions will occur through EO 12969. This can increase the environmental costs for weapon system acquisitions.

Table 6- 1. Environmental Cost Elements by Cost Element and Acquisition Phase

CES/ WBS	Element Name	Pollution Prevention	Resource Preservatn	Remed / Restore	Demil	Final Disposal	SE/PM	Comply	Liability Risk
1.0	**RDT&E**								
1.01	Dev Eng	X				X	X		X
1.02	PEP	X				X	X	X	
1.03	Dev Tool	X							
1.04	Proto Mfg	X	X				X	X	
1.05	SE/PM	X							
1.06	ST&E	X					X		
1.07	Training	X							
1.08	Data	X							
1.09	Spprt Equip				X				
1.10	Dev Fac	X						X	X
1.11	Other RDT&E								
2.0	**Procurement**								
2.01	Nonrecr Prod	X	X			X	X	X	X
2.02	Recur Prod	X	X				X	X	X
2.03	Engr Chng	X				X	X	X	
2.04	SE/PM	X					X		
2.05	ST&E	X					X		
2.06	Training	X							
2.07	Data	X							
2.08	Spprt Equip	X							
2.09	Op/Site Act	X	X					X	
2.10	Fielding	X							
2.11	Tng Ammo/Msl	X							
2.12	WR Ammo/Msl	X							
2.13	Mods	X							
2.14	Other								
3.0	**Mil Constrct**								
3.01	Dev Constrct	X					X		
3.02	Prod Constrct	X					X		
3.03	Op/Site Act	X					X		
3.04	Other			X	X	X	X		
4.0	**Mil Pay**								
4.01	Crew								
4.02	Maintenance								
4.03	Sys Spec Spprt								
4.04	SE/PM						X		
4.05	Repl Persnl						X		
4.06	Other								
5.0	**O&M**								
5.01	Fld Maint (Civ)			X			X		X
5.02	Sys Sp Base Op	X		X	X	X			
5.03	Spares	X							
5.04	Repr Parts	X							
5.05	POL	X							
5.06	End Item S&M	X			X	X			
5.07	Transportation	X		X	X	X			
5.08	Software	X							
5.09	ST&E	X		X		X			
5.10	SE/PM	X		X	X	X	X		
5.11	Training	X			X	X			
5.12	Other			X		X			
6.0	**AWCF**								
6.01	Class IX Wr Res								
6.02	Other								
7.0	**Disposal**	X	X	X	X	X	X	X	X

Table 6-2. Weapon Systems Environmental Life Cycle Costs WBS

1.0 Environmental Security

- 1.1 Compliance Plans, Permits, Reports, Tests & Assessments
  - 1.1.1 Air Emissions (Example Detail)
    - 1.1.1.1 Plans, Reports, Permits
    - 1.1.1.2 Audits & Assessments
  - 1.1.2 Hazardous Materials
  - 1.1.3 Hazardous & Radioactive Waste
  - 1.1.4 Noise
  - 1.1.5 Pesticides
  - 1.1.6 Petroleum, Oils & Lubricants
  - 1.1.7 Solid Waste
  - 1.1.8 Water & Wastewater
  - 1.1.9 Special Programs
- 1.2 Pollution Prevention/Waste Minimization
  - 1.2.1 Air Emissions
    - 1.2.1.1 Fuel Burners
    - 1.2.1.2 Incinerators
    - 1.2.1.3 Volatile Organic Chemicals
    - 1.2.1.4 Vehicles & Mobile Sources
    - 1.2.1.5 Ozone-Depleting Chemicals
    - 1.2.1.6 Particulates
    - 1.2.1.7 Air Toxics, Metals
    - 1.2.1.8 Area Sources
  - 1.2.2 Hazardous Materials Handling
    - 1.2.2.1 Storage Structures
    - 1.2.2.2 Operations & Handling
  - 1.2.3 Hazardous Solid & Radioactive Waste
    - 1.2.3.1 Accumulation & Interim Storage
    - 1.2.3.2 Pre-Treatment, Material Separations, and Recycling
    - 1.2.3.3 Treatment, Storage, & Disposal
  - 1.2.4 Noise Reduction Processes
  - 1.2.5 Pesticides & Herbicides
  - 1.2.6 Petroleum, Oils, & Lubricants
    - 1.2.6.1 Above-Ground Tanks
    - 1.2.6.2 Underground Tanks
    - 1.2.6.3 Drum Storage
    - 1.2.6.4 Waste Treatment
    - 1.2.6.5 Separations & Recycling
  - 1.2.7 Solid Non-Hazardous Waste
    - 1.2.7.1 Material Separations & Recycling
    - 1.2.7.2 Landfills & Receptacles
    - 1.2.7.3 Medical Waste & Special Programs
  - 1.2.8 Water Quality & Wastewater Treatment
    - 1.2.8.1 Water Supply & Distribution System
    - 1.2.8.2 Domestic Wastewater Treatment & Reclamation
    - 1.2.8.3 Industrial Wastewater & Treatment
    - 1.2.8.4 Storm water Runoff Collection & Treatment
  - 1.2.9 Special Programs
    - 1.2.9.1 PCBs
    - 1.2.9.2 Asbestos
    - 1.2.9.3 Radon
    - 1.2.9.4 Lead-based Paint
    - 1.2.9.5 Low-level Radiation
    - 1.2.9.6 Explosives/Energetics
- 1.3 Natural/Cultural Resource Preservation
  - 1.3.1 Biological & Recreational Resources
  - 1.3.2 Cultural/Historic Resources
  - 1.3.3 Wetlands/Floodplains
  - 1.3.4 Land Use
- 1.4 Remediation & Restoration
  - 1.4.1 RI/FS & Site Assessments
  - 1.4.2 Restoration Design
  - 1.4.3 Remediation Processes
    - 1.4.3.1 Ground Water
    - 1.4.3.2 Surface Water
    - 1.4.3.3 In-Situ Soil
    - 1.4.3.4 Ex-Situ Soil/Solids
- 1.5 Demilitarization & Disposal
  - 1.5.1 Facilities
    - 1.5.1.1 Facilities Deactivation/Equipment Dismantlement & Caretaker Activities
    - 1.5.1.2 Facility Decontamination
    - 1.5.1.2.1 Surface Removal of Particulate Materials
    - 1.5.1.2.2 Surface Removal of Organic/Metal Oxide Chemicals
    - 1.5.1.2.3 Surface Removal of Radioactive Materials
    - 1.5.1.2.4 Asbestos Abatement
    - 1.5.1.3 Facilities Demolition
  - 1.5.2 Equipment/Systems/Materials
    - 1.5.2.1 Demilitarization & Disposal Process Equip/Facility Design & Construction
    - 1.5.2.2 Interim Storage
    - 1.5.2.3 Disassembly, Disposition, and Disposal
- 1.6 Management
  - 1.6.1 Management & Technical Support
  - 1.6.2 Training
  - 1.6.3 Health & Safety Support
  - 1.6.4 Public Relations
- 1.7 Cost & Liability Risk
  - 1.7.1 Air Emissions
  - 1.7.2 Hazardous Materials
  - 1.7.3 Hazardous & Radioactive Waste
  - 1.7.4 Noise
  - 1.7.5 Pesticides
  - 1.7.6 Petroleum, Oils, & Lubricants
  - 1.7.7 Solid Waste
  - 1.7.8 Water & Wastewater
  - 1.7.9 Unknowns

1.0 Environmental Security

This WBS includes all the costs associated with a system's compliance with environmental laws and regulations. These are the costs directly associated with compliance-driven activities (e.g., processes, equipment, fees, labor, materials). These costs are those that can be directly allocated to meeting specific regulations and directives that pertain to environmental impacts.

1.1 Compliance Plans, Permits, Reports, Tests & Assessments

This element includes all the costs associated with preparing compliance documentation. Include also the cost of systematic, interdisciplinary studies that support the documentation of environmental impacts. Include here application fees, settlements, fines, reimbursements paid to state governments or other municipalities and all payments made to legally certify operations. Include the cost for toxicology testing of new materials/chemicals necessary to comply with the Toxic Substance Control Act (TSCA). Also include the cost to prepare the Premanufacturing Notice that lists the materials or chemicals--a necessary step to obtaining a license to manufacture the product. Include one-time surveys as well as recurring monitoring activities that support compliance documentation. Examples include performance of environmental impact statements.

1.1.1 Air Emissions (Example Detail)

This element includes all the costs associated with Air Emissions Compliance Plans, Permits, Reports, & Assessments. An example may be the performance of an environmental baseline study for Clean Air Act compliance.

1.1.2 Hazardous Materials

This element includes all the costs associated with Hazardous Materials Compliance Plans, Permits, Reports, & Assessments. Include the cost to comply with the general requirements for introduction of new, toxic and/or chemical material, the cost for toxicology testing to comply with the Toxic Substance Control Act, and the cost to prepare the Premanufacturing Notice needed in order to obtain a license to manufacture the product.

1.1.3 Hazardous & Radioactive Waste

This element includes all the costs associated with Hazardous & Radioactive Waste Compliance Plans, Permits, Reports, & Assessments. Examples include permits obtained to treat, store, or dispose of hazardous and radioactive waste; development, maintenance, and submittal of spill contingency plans, spill prevention control and countermeasure plans, and hazardous waste management plans; waste analysis plans and the maintenance of waste analysis and test results; waste transport manifesting records and biennial reports to EPA; waste discharge reports, processing and storage equipment inspection plans and logs;,

1.1.4 Noise

This element includes all the costs associated with Noise Compliance Plans, Permits, Reports, & Assessments. Conducting a noise survey and determining compatible use zones are examples.

1.1.5 Pesticides

This element includes all the costs associated with Pesticides Compliance Plans, Permits, Reports, & Assessments. An example may be performance of a pesticide survey for compliance with the Federal Insecticide, Fungicide, and Rodenticide Act.

1.1.6 Petroleum, Oils, & Lubricants

This element includes all the costs associated with Petroleum, Oils, & Lubricants Compliance Plans, Permits, Reports, & Assessments

1.1.7 Solid Waste

This element includes all the costs associated with Solid Waste Compliance Plans, Permits, Reports, & Assessments.

1.1.8 Water & Wastewater

This element includes all the costs associated with Water & Wastewater Compliance Plans, Permits, Reports, & Assessments. An example may be to maintain a nonpoint source storm water management plan.

1.1.9 Special Programs

This element includes all the costs associated with Special Programs Compliance Plans, Permits, Reports, & Assessments.

1.2 Pollution Prevention/Waste Minimization

This element includes all the costs associated with Pollution Prevention/Waste Minimization. It includes the development of pollution prevention and waste minimization programs as well as their implementation. Include here the hands-on control of hazardous material for all processes throughout each phase. Examples may include capital outlay for equipment used to capture and store waste, changes to manufacturing processes and other operations in order to minimize the use and production of hazardous materials, lost productivity due to personnel protection equipment, or the cost of operating a hazardous material pharmacy system. Include here also fees paid for off site disposal of waste material.

1.2.1 Air Emissions

This element includes all the costs associated with Air Emissions Pollution Prevention/Waste Minimization. Contributors to this item might include fuel burners, incinerators, vehicles and mobile sources, as well as other area sources. Examples include the installation of exhaust scrubber and filtration systems, radon detection systems, and fume hoods.

1.2.1.3 Volatile Organic Chemicals

This element includes all the costs associated with detecting the presence and minimizing the generation of volatile organic chemicals (VOCs) from various manufacturing processes.

1.2.1.5 Ozone-Depleting Chemicals

This element includes all the costs associated with detecting the presence and minimizing or eliminating the use or production of various ozone-depleting chemicals such as chloro-fluoro-carbons (CFCs).

1.2.1.6 Particulates & Metals

This element includes all the costs associated with detecting and minimizing the production of fine particulates and air-borne metals from manufacturing processes.

1.2.1.7 Air Toxins, Metals

This element includes all the costs associated with detecting the presence and minimizing or eliminating the production of various volatile inorganic chemicals such as nitrogen oxides (NO_x) and sulfur oxides (SO_x).

1.2.2 Hazardous Materials Handling

This element includes all the costs associated with the handling of hazardous materials which are required for certain manufacturing processes or other operations.

1.2.2.1 Storage Structures

This element includes all the costs associated with storing the relevant hazardous materials prior to their use.

1.2.2.2 Operations & Handling

This element includes all the costs associated with the handling of hazardous materials during their use in the relevant operations.

1.2.3 Hazardous Solid & Radioactive Waste

This element includes all the costs associated with the accumulation, storage, treatment, and disposal of hazardous solid and radioactive wastes, as defined under the Resource conservation and Recovery Act (RCRA), which are produced from various manufacturing processes and other operations. It also includes the costs for detecting the presence of such materials, the costs for any process modifications which would result in minimizing the production of these wastes, as well as the costs associated with the use of new processes or improvements to existing processes for the treatment and disposal of these wastes.

1.2.3.1 Accumulation & Interim Storage

This element includes all the costs associated with the accumulation and interim storage of hazardous solid and/or radioactive wastes prior to any treatment or disposal.

1.2.3.2 Pre-Treatment, Material Separations & Recycling

This element includes all the costs associated with the pre-treatment of hazardous solid and/or radioactive wastes as well as the separation of various materials for recycling or for further treatment/disposal.

1.2.3.3 Treatment, Storage, and Disposal

This element includes all the costs associated with any further treatment of the hazardous solid and/or radioactive wastes as well as any further separation of treated products. It also includes all the costs associated with the storage and proper disposal of the end-products of the hazardous solid and/or radioactive wastes after the appropriate treatment processes.

1.2.4 Noise Reduction Processes

This element includes all the costs associated process improvements intended for reducing the noise level associated with these processes. Installation of berms and noise monitoring equipment at a firing range is an example.

1.2.5 Pesticides/Herbicides

This element includes all the costs associated with detecting the presence of pesticides/herbicides and minimizing or eliminating the use and release of these chemicals.

1.2.6 Petroleum, Oils & Lubricants

This element includes all the costs associated with handling, storage, treatment and disposal of petroleum, oils and lubricants which are used in various processes and operations.

1.2.6.1 Above-Ground Tanks

This element includes all the costs associated with the storage of petroleum, oils and lubricants in above-ground tanks.

1.2.6.2 Underground Tanks

This element includes all the costs associated with the storage of petroleum, oils and lubricants in underground tanks.

1.2.6.3 Drum Storage

This element includes all the costs associated with the storage of petroleum, oils and lubricants in drums.

1.2.6.4 Waste Treatment

This element includes all the costs associated with the treatment of petroleum, oil and lubricant wastes.

1.2.6.5 Separations & Recycling

This element includes all the costs associated with separating the products of the treatment processes of petroleum, oil and lubricant wastes, and the recycling of useful products as well as the proper disposal of the remaining wastes.

1.2.7 Non-Hazardous Solid Waste

This element includes all the costs associated with the handling, separations, recycling and disposal of non-hazardous solid wastes which result from various manufacturing processes and other operations.

1.2.7.1 Material Separations & Recycling

This element includes all the costs associated with the separations of various materials present in the solid wastes for further recycling or ultimate disposal. This element may include sorting, shredding, smashing, and compacting as well as containerization.

1.2.7.2 Landfills & Receptacles

This element includes all the costs associated with disposing of the non-hazardous waste which is not of any further value in landfills and receptacles.

1.2.7.3 Medical Waste & Special Programs

This element includes all the costs associated with the handling, separations, recycling and disposal of medical wastes and the non-hazardous solid wastes which result from other special programs.

1.2.8 Water Quality & Wastewater Treatment

This element includes all the costs associated with testing and determining the quality of water associated with various manufacturing processes and other operations as well as the treatment of wastewater prior to its release.

1.2.8.1 Water Supply & Distribution System

This element includes all the costs associated with the water supply and distribution system for use with various processes and operations. Examples include rehabilitation of supply lines and installation of chlorinators.

1.2.8.2 Domestic Wastewater Treatment & Reclamation

This element includes all the costs associated with domestic wastewater treatment and reclamation. Examples include installation of backflow prevention devices or sewer system upgrades.

1.2.8.3 Industrial Wastewater & Treatment

This element includes all the costs associated with industrial wastewater handling and its treatment. Examples include the installation of sludge settling ponds.

1.2.8.4 Storm water Runoff Collection & Treatment

This element includes all the costs associated with storm water runoff collection and treatment.

1.2.9 Special Programs

This element includes all the costs associated with the accumulation, storage, treatment, and disposal of hazardous process feed materials and wastes associated with Special Programs such as PCBs, asbestos, radon gas, lead-based paint, low-level radiation, and explosives/energetics.

1.2.9.1 PCBs

This element includes all the costs associated with the accumulation, storage, treatment, and disposal of polychlorinated biphenyls (PCBs). It also includes the costs associated with the detection of these compounds as well as the costs of process improvements for minimizing or eliminating the production or use of these compounds.

1.2.9.2 Asbestos

This element includes all the costs associated with the accumulation, storage, treatment, and disposal of asbestos as well as appropriate changes to processes to reduce or eliminate the use or production of asbestos.

1.2.9.3 Radon

This element includes all the costs associated with the detection of radon gas and the necessary measures which are required to dealing with its presence.

1.2.9.4 Lead-based Paint

This element includes all the costs associated with the handling, treatment and disposal of wastes containing lead-based paint. It also includes the costs of process improvements for minimizing or preventing the use and production of such materials.

1.2.9.5 Low-level Radiation

This element includes all the costs associated with the accumulation, storage, treatment and disposal of low-level radiation wastes. It also includes the costs of process improvements for minimizing or preventing the use and production of such materials, the costs for handling and tracking the hazardous material during manufacturing and testing, and numerous other miscellaneous costs such as Nuclear Regulatory Commission licenses, EPA/State permits, personnel monitoring and protection, training, tracking, recording, construction of special enclosed areas, etc.

1.2.9.6 Explosives/Energetics

This element includes all the costs associated with the handling, storage, treatment and disposal of explosives and energetics. The activities include the cost of open burning, open detonation, furnace operation, or propellant reclamation operations. This element will also include the cost of consumables such as donor charges for open detonation or pallets that are consumed in open burning.

1.3 Natural/Cultural Resource Preservation

This element includes all the costs associated with Natural/Cultural Resource Preservation for use by future generations. Example of this element may include relocating operations away from proximity to resources requiring protection.

1.3.1 Biological & Recreational Resources

This element includes all the costs associated with Biological & Recreational Resource Preservation. Examples may include inventorying vegetation or wildlife, maintaining habitats, dam modification, and tree planting.

1.3.2 Cultural/Historic Resources

This element includes all the costs associated with Cultural/Historic Resource Preservation. Examples may include an archeological survey, relocating graves, or rehabilitating buildings.

1.3.3 Wetlands/Floodplains

This element includes all the costs associated with Wetlands/Floodplains Resource Preservation.

1.3.4 Land Use

This element includes all the costs associated with Land Use Resource Preservation.

1.4 Remediation & Restoration

Environmental cleanup involves the remediation of soils, sediment, groundwater, surface water, and structures contaminated with hazardous and toxic materials from past activity. Examples of remedial cleanups include capping and monitoring landfills, excavating and disposing of river sediments, pumping and treating groundwater, and incinerating or biologically treating soils. Generally a remedial action that permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances is preferred over an action that removes the untreated substances to another location. Include RCRA and CERCLA cleanup activities.

1.4.1 RI/FS & Site Assessments

This element includes all the costs associated with Remedial Investigations (RI) or Feasibility Studies (FS) & Site Assessments. Include efforts to determine the extent of hazardous substance contamination and to conduct treat ability investigations. The objective is to identify alternatives for remediation and to select and describe a remedial action. These studies gather data to determine the type and extent of contamination at a site, establish cleanup criteria, and analyze the feasibility and cost of alternative cleanup methods. This step maps out the nature and extent of a site's waste hazards and evaluates alternative responses. The Remedial Investigation includes sampling and monitoring to characterize the site and supports subsequent evaluation of remedial alternatives. The Feasibility Studies are used to develop and evaluate options for remedial action. The completion of this step results in a Record of Decision (ROD) which is a legally binding documentation of the particular remedy.

The RI/FS may be preceded by a screening process comprised of an initial Preliminary Assessment followed by a Site Inspection. The Preliminary Assessment is largely a review of available documents concerning the site's history. The Site Inspection involves the collection and analysis of field data to determine if further action or investigation is appropriate.

1.4.2 Restoration Design

This element includes all the costs associated with Restoration Design. These are the engineering design activities to develop drawings and specifications required to implement the chosen remedial alternatives.

1.4.3 Remediation Processes

This element includes all the costs associated with Remediation Processes. This includes the construction and operation of the selected remedy. Sometimes this is represented by a one-time capital construction period and a subsequent operations and maintenance phase.

1.4.3.1 Ground Water

This element includes all the costs associated with Ground Water Remediation Processes.

1.4.3.2 Surface Water

This element includes all the costs associated with Surface Water Remediation Processes.

1.4.3.3 In-Situ Soil

This element includes all the costs associated with In-Situ Soil Remediation Processes.

1.4.3.4 Ex-Situ Soil/Solids

This element includes all the costs associated with Ex-Situ Soil/Solids Remediation Processes.

1.5 Demilitarization & Disposal

This element captures costs associated with disposing of a system or facility at the end of their useful life. Disposal is the process of redistributing, transferring, donating, selling, or demilitarizing the system. Demilitarization is a subset of disposal and is the act of deactivating or rendering inoperable by destroying the military offensive or defensive advantage inherent in an item. Where applicable, this category includes salvage values as well as costs incurred during the phase-out period. The complete deactivation and demilitarization of a system entails not only the disposal of hazardous wastes but also the proper disposition of inert materials and support equipment as well.

1.5.1 Facilities

This element includes the cost of deactivating an operational or production facility. Include the cost to transition the facility to a caretaker status, preserve its capability in state (mothball), or complete razing to grade, as appropriate. Include here also the cost of tooling disposal.

1.5.1.1 Facility Deactivation/ Equipment Dismantlement & Caretaker Activities

This element includes the cost of facility deactivation. Equipment dismantlement is applicable to the facility tanks, utilities, and equipment. It is the physical removal of equipment from a building or structure, and includes the salvage value of any removed material. This element also includes the cost of those activities necessary to transition an active facility into mothballs. Examples of such efforts are draining plumbing, boarding windows, or removing electrical service. Includes the cost of painting, maintenance of fire protection equipment, utilities, security, and consumables.

1.5.1.2 Facility Decontamination

This element includes the cost of Decontamination of buildings, equipment, and structures can increase a building's value, return it to usable status, or to minimize the volume of hazardous waste upon demolition. Includes the cost of neutralizing, collecting, and containing the resulting waste liquid or the debris, but not waste treatment or disposal. Includes cost to remove obstructions, and worker protection.

1.5.1.2.1 Surface Removal of Particulate Materials

This element includes the cost of dusting/vacuuming/wiping using conventional cleaning techniques to remove particulate waste from surfaces. Using abrasive materials such as sand, steel pellets, alumina, or glass beads to remove surface contaminates.

1.5.1.2.2 Surface Removal of Organic / Metal Oxide Chemicals

This element includes the cost of cleaning techniques on surfaces contaminated with explosives, heavy metals contaminates.

1.5.1.2.3 Surface Removal of Radioactive Materials

This element includes the cost of surface removal of radioactive materials.

1.5.1.2.4 Asbestos Abatement

This element includes the costs associated with asbestos removal. Include the costs of preparation, construction of the decontamination and containment enclosures, asbestos removal, and equipment.

1.5.1.3 Facility Demolition

This element includes the cost of building or structure demolition.

1.5.2 Equipment/Systems/Materials

Include in these elements the cost of disposing of mission equipment for a disposal phase demilitarization effort as well as disposal of waste stream material throughout the life cycle.

1.5.2.1 Demilitarization & Disposal Process Equip/Facility Design and Construction

This element includes the cost of the study, analysis, design development, evaluation, testing, and redesign of the processes to demilitarize the system. This element includes the cost of real estate, construction, conversion, utilities, and equipment (e.g., tools, fixtures, test equipment) to achieve the demilitarization capability.

1.5.2.2 Interim Storage

This element includes the cost of storage after items have been removed from service and prior to disposition.

1.5.2.3 Disassembly, Disposition, and Disposal

This element includes the cost of demilitarizing prime mission equipment as well as any peculiar support equipment and trainers. Includes the costs of disassembly, recovery, and/or salvage of the system or its constituent parts. This also includes the cost to check out or certify parts reclaimed for use as spares or other applications.. Does not include treatment or disposal of waste as this is included in 1.2 for waste minimization. This element includes the salvage value of these materials sold as scrap through Defense Reutilization and Marketing Office (DRMO).

1.6 Management

Environmental program management includes the development of plans and programs associated with environmental pollution prevention, compliance and conservation. The professional support functions associated with these plans, programs, and other environmental management activities are also include in this element. The activities addressed include those environmental related efforts to support program activities, support RFP preparation, support source selection, review CDRL deliverables, attend IPRs, accept IPR actions, travel as required, support Cost Analysis Requirement Document (CARD) preparation and update, performing initial environmental analysis and planning, review environmental trade studies, update Life Cycle Environmental Documents, and prepare Annex E of the Integrated Program Summary. Include where applicable, both Government and contractor efforts.

1.6.1 Management & Technical Support

This element includes activities performed by professional staff to develop plans and programs to manage, procure, distribute, control, treat, store, dispose, and monitor hazardous material and waste.

1.6.2 Training

This element includes all the costs associated with Training. This element includes increasing education and awareness; developing or buying videos, books, journals, publications, reference works, pamphlets, or brochures; attending seminars, workshops, orientation sessions, courses; and taking part in activities so that employees can obtain certification.

1.6.3 Health & Safety Support

This element includes all the costs associated with Health & Safety Support.

1.6.4 Public Relations

This element includes all the costs associated with Public Relations. The cost of public hearings for specific permits are associated with those elements.

1.7 Cost & Liability Risk

This element includes all the costs associated with Cost & Liability Risk. include the cost of settling legal claims from employees and public citizens who are injured as a result of exposure to hazardous materials. Examples are claims for wrongful death, pain and suffering, lost time due to disability, and medical costs. Also include cost of property devaluation resulting from contamination of private or public property.

1.7.1 Air Emissions

This element includes all the Cost & Liability Risk associated with Air Emissions.

1.7.2 Hazardous Materials

This element includes all the Cost & Liability Risk associated with Hazardous Materials.

1.7.3 Hazardous & Radioactive Waste

This element includes all the Cost & Liability Risk associated with Hazardous & Radioactive Waste.

1.7.4 Noise

This element includes all the Cost & Liability Risk associated with Noise.

1.7.5 Pesticides

This element includes all the Cost & Liability Risk associated with use of Pesticides.

1.7.6 Petroleum, Oils, & Lubricants

This element includes all the Cost & Liability Risk associated with Petroleum, Oils, & Lubricants.

1.7.7 Solid Waste

This element includes all the Cost & Liability Risk associated with Solid Waste.

1.7.8 Water & Wastewater

This element includes all the Cost & Liability Risk associated with Water & Wastewater.

1.7.9 Unknowns

This element includes all the Cost & Liability Risk associated with Unknowns.

CHAPTER 7 - FORCE COSTING

7- 1. Introduction

a. The Army force cost mission is to estimate the cost of the different configurations of people and equipment which make up force units. Force units are detachments, squads, platoons, companies, battalions, brigades, divisions, corps, or armies. A detachment is the smallest force unit, and an Army is the largest. Force unit estimates increase in complexity as the units become larger. Most force cost estimates are done from detachment to division level. Additionally, the number of personnel in each type of unit varies. For example, an armor platoon consists of four tanks and sixteen soldiers. An infantry platoon consists of three squads which equals 38 to 42 soldiers. Traditionally, force units have consisted entirely of soldiers. However, this is changing. In Desert Storm as well as Operation Just Cause contractor personnel were deployed and performed previously soldier only missions such as equipment repair.

b. There are two methods used to capture the number of personnel and equipment in force units: the Standard Requirement Code (SRC) method which equates to the Table of Organization and Equipment (TOE) and the Modified Table of Organization and Equipment (MTOE) method. For force costing purposes, SRCs represent all the types of force units that can exist. At present there are more than 2,000 different types of TOE units or SRCs. Presently, there are 5,000 MTOE units in the force structure.

c. Force costing is a process that identifies and estimates the costs associated with a force unit. For those familiar with weapon system costing, as weapon systems are said to have a life cycle so do force units. However, instead of having Development, Production, Fielding, and Sustainment phases, force units have Acquisition of Resources, Activation, Annual Operations, Movement, Modification, Inactivation, and Conversion phases.

d. The Acquisition of Resources and Annual Operations phases provide the basic costs upon which all other options rest.

7- 2. Activation/acquisition

a. This represents the one-time (nonrecurring) costs associated with bringing a force unit into being. It answers the question "How much does it cost to acquire a new unit?" This includes the cost for outfitting a unit with the equipment, basic loads, and personnel required by organizational documents. When additional facilities are needed to support the new force, these costs also are included.

b. The major cost categories are shown below:

(1) Materiel

(a) This is the total cost of aircraft, missiles, weapons, combat and tracked vehicles, other procurement, and ammunition in a unit's table of organization and equipment (TOE). The product of the unit price of each piece of equipment and its density is summed to provide the nonrecurring cost of equipment within a unit.

(b) Ammunition initial issue is similarly costed. The nonrecurring cost of the unit's ammunition basic load is calculated by ammunition type. Ammunition round price is multiplied by density and then summed for all types.

(c) Organizational clothing and individual equipment are identified and similarly costed.

(d) Consolidated tables of allowances (CTAs) are identified and similarly costed.

(e) Prescribed Load Lists (PLLs)/Authorized Stockage Lists (ASLs) are similarly costed.

(f) The basic load requirements for Class 1 (Subsistence), Class II (Chemical Defense Equipment) and Class III (Packaged POL such as cans of oil) are identified and similarly costed.

(g) The publication cost is the product of total pages of technical manuals required for the unit and the cost per page.

(2) Personnel

This is the total cost of bringing soldiers into the force through initial Military Occupational Specialty (MOS). This includes MPA; Operations and Maintenance, Army (OMA); and procurement costs for pay, allowances, and training and initial clothing issue.

7- 3. Annual Operations

This option provides the recurring costs that a force unit either expends annually (direct) or requires to be obligated by the Army because the unit exists (indirect). The major cost elements include: direct Equipment Parts and Fuel Costs, indirect Support Costs, other training support, personnel, and other unit support.

a. Direct Equipment Parts and Fuel Costs include:

(1) The number of miles driven or the number of hours major end items of equipment are operated. It drives the direct recurring costs of training operations. The equipment's hours or miles of operation for a required readiness rating is multiplied by its cost factors for oil and lubricants, consumables and reparables. The products of the unit of operation times each cost factor are summed together to provide the direct recurring training cost of a unit.

(2) Training ammunition and missiles that are expended during normal annual training for familiarization or qualification.

b. Indirect Support Costs are those incurred in support of a unit's training but not directly related to the number of miles driven or hours equipment is operated and include:

(1) Transportation to training sites includes the cost of sending a unit to the National Training Center (NTC). For a Reserve Component (RC) unit, this includes the cost to send the unit to the annual training site.

(2) Supplies for normal housekeeping and maintenance in the unit such as reimbursable items through the General Services Administration (GSA).

(3) Contractual Services–Field includes the cost for special support items required outside the continental United States (OCONUS) units during field training.

(4) Mission travel of personnel in support of training or operational requirements.

(5) Equipment leases for items such as copiers.

(6) Contractual services for automated data processing (ADP) equipment and other items.

(7) Purchased commercial equipment that is not free issue to the unit and is required for normal garrison activities.

(8) Administrative travel that the unit members must complete unrelated to training activities.

(9) Civilian labor is used to augment table of distributions and allowances (TDA) civilians required at an OCONUS location. Continental United States (CONUS) civilians are normally paid through base operations/real property maintenance (BASOPS/RPMA) accounts.

(10) Other costs borne by the unit in support of training but not directly linked to miles driven or hours equipment is operated.

c. Personnel includes:

(1) Replacement personnel. The cost to train a soldier for each specific MOS, multiplied by the expected number of annual MOS replacements.

(2) Permanent change of station (PCS) travel for military personnel and their dependents based on the transfer rate.

(3) All pay, allowances, and benefits for military personnel. This includes basic pay (BP), basic allowance for quarters (BAQ), basic allowance for subsistence (BAS), retired pay accrual (RPA), and variable housing allowance (VHA), summed across all grades. Specialty pays are included when appropriate.

d. Other unit support includes:

(1) BASOPS/RPMA that is attributable to that unit being on the post.

(2) Medical support below general hospitals required for the soldier and dependents in dispensaries, etc.

(3) Army family housing O&M.

(4) Army family housing leases.

(5) Other support chargeable against a unit but not captured anywhere else.

7- 4. Modification

This option provides the costs and savings resulting from the removal or exchange of equipment and/or personnel during force modernization or modification. This option represents only the marginal costs resulting from the reorganization. The estimation process is highly dependent on the conditions affecting the reorganization. One example of a reorganization is when an M1A1 tank battalion is changed to an M1A2 battalion. The procurement of the M1A2 tank is a nonrecurring cost. The operating cost of the displaced M1A1 tank is a recurring cost avoidance. This is, however, offset by the operating cost of the new M1A2 tank. The new M1A2 battalion requires new MOSs that are addressed in the personnel and training systems. Inherited assets are equipment and personnel that are common to both units. Inherited assets that are currently available equipment are neither a cost nor a savings to the reorganization. Marginal changes are the only significant items to be costed.

7- 5. Movement

a. There are two types of force unit movements: administrative moves and tactical moves. An administrative move is when a unit moves its home base. Many of these moves occurred in 1996 as part of the restructuring of the total force. Administrative moves can easily be differentiated from tactical moves by asking the question, do the families of the soldiers move? If the families move with the soldiers, the move is administrative. If the families don't move with the soldiers, the move is tactical. Tactical moves are movements of force units for purposes of war or contingency operations. In an administrative move, one-time costs are incurred to transport the people and equipment to the new location. In a tactical move, round-trip costs are incurred.

b. The costs to move the unit are straightforward. A factor per ton-mile for the mode of transportation is multiplied by the tonnage to be shipped over the distance to be traveled. However, for administrative moves there is an impact on the installations for both the losing and gaining post. These costs are very situation dependent. For tactical moves, analysts should determine if they need to include indirect costs related to movement such as soldier inoculation fees.

c. Disposition of unit equipment will not only dictate the direct cost of the move, but may change the mode of transportation. All TOE equipment will move when a unit moves. However, a unit owns much more equipment than that shown in its TOE. The analyst or decision maker must determine the depth of the cost estimate; if not, there is a strong chance of underestimating the cost involved.

d. Another cost/savings consideration is the status of facilities on the installation gaining or losing soldiers. In administrative moves the availability of a support base on the gaining installation or community must be compared with savings generated at the losing installation. In tactical moves, soldiers may be moving where there is a bare base environment. The gain or loss of both military and civilian support personnel at both installations must also be taken into account for both types of movements. Moving will also show a cost or saving depending on the difference in VHA at each location for administrative moves.

e. Military personnel moves can cause an out-of-cycle PCS. However, when relocation can be planned over the normal rotation period, the marginal PCS can be reduced or absorbed through normal PCS turnover. Civilian moves always incur added costs.

7- 6. Inactivation

a. This option estimates both nonrecurring costs and recurring savings resulting from the removal of a unit from the force. This option is the most situation dependent of any discussed. Reasonable assumptions that address detailed information on the process, schedule, and ultimate disposition of people, equipment, and facilities form the basis for a reliable estimate.

b. Not all identified operating costs translate into savings of an inactivated unit. When the inactivated personnel are reassigned and there is no decrease in the end strength of the Army, then there are no savings in MPA. It is normally assumed that only one-half of any savings is achieved in the first year, while all costs are reflected. This convention assumes that the decrease is on-the-average at the midpoint. Savings are available for only half a year. However, all costs such as severance pay and transportation are chargeable.

c. The analyst must consider several areas under an inactivation:

(1) Disposition of equipment. Regardless of what happens to the equipment, the Army will incur costs. Unless the Army decides to leave the equipment as it is, there is a cost to bring the equipment up to

standard. When the equipment is moved to another unit or into a storage site, the Army incurs costs. However, a marginal savings results when the equipment is operated fewer miles or hours than before. When the Army sells equipment, the proceeds do not necessarily return to the Army. So the only savings or cost avoidance credited results from reduced operating costs.

(2) Disposition of facilities. As previously discussed, closing of facilities can provide savings after any costs to mothball facilities are considered.

(3) Impact on military personnel. If there is a concurrent reduction in the end strength of the Army with an inactivation, there are costs for moving the military personnel, and severance pay for the officers and enlisted personnel. During an inactivation, movement of military personnel may require two changes of station. The first PCS occurs when the inactivated-unit members are reassigned and moved to a new unit. The second PCS occurs when a second individual is removed from the force, creating a separation PCS. Because of uncertain time of initiation, the first-year MPA savings are limited to one-half of the associated staff reductions.

(4) Pay and allowances. The savings generated will be the BP, BAQ, BAS, and RPA of the affected military personnel within the unit being inactivated.

(5) Impact on civilian work force. Inactivation also can reduce the civilian work force. Civilians can be eligible for severance pay, worth up to one-half of their base pay. Results of inactivations under the Base Realignment and Closure (BRAC) Commission reveal that not all civilians opt to take severance pay. Their choices are to either to take an early retirement, find other Government employment, or resign without severance pay. So, some savings can result during the first year that a civilian reduction in force (RIF) occurs. Using the midyear convention, civilian work force savings are small during the first year, and do not reach full potential until the year after all reductions have taken place.

7- 7. Conversions

a. Conversion is the transfer of a unit from the Active Component (AC) to the Reserve Component (RC). Conversion costs depend very much on the situation and other concurrent plans. There is normally an inactivation of the AC unit with a concurrent inactivation, activation, or modification of the RC unit. Equipment is likely to be moved from the AC location to the RC location. Therefore, the considerations just listed for the various options must be addressed as well as some new ones.

b. The "new" RC unit will most likely have a different SRC from the inactivating AC unit. This requires that the gaining RC unit obtain the proper equipment to qualify it as the new SRC. Inherited assets must be considered for the new unit to minimize excess equipment inventories. When the AC equipment transfers to the RC unit, transportation costs must be included. There is also a cost associated with the removal of the displaced equipment from the RC unit.

c. The size of the recruiting base may impact the cost of the RC unit. This is especially true if the unit grows or changes type radically. When the old and new MOSs are significantly different, the formal training burden will increase. When the unit size increases, the Reserve center or armory may need to be expanded to contain the growth. Support equipment may need to be upgraded, especially if an RC unit changes from having little equipment to being equipment heavy. If the RC unit is located in a sparsely populated region, it may require the decentralization of the unit to increase its recruiting potential, resulting in adding senior headquarters costs for administration.

d. A conversion involves both nonrecurring costs to effect the change and recurring savings or cost avoidances. When the RC unit gets new equipment, a new recurring operating cost is incurred. Although OMA funds may be saved in the AC, the conversion can increase the RC operating costs.

7- 8. Force and Organization Cost Estimating System (FORCES)

a. Because of the magnitude of people paid at different rates and the vast amount and types of equipment involved in force costing, force costing lends itself to automation. The suite of tools developed and used by CEAC to perform force costing is called FORCES. FORCES consists of the Force Cost Model (FCM), the Army Cost Factors Handbook (Handbook), the Exportable Force Cost Data Base (EFCDB), the Civilian Manpower Reduction Model (CMRM), and the Military Endstrength Reduction Model (ESR). The most important part of the suite is the FCM. FCM is the primary tool used at CEAC to estimate the cost of force units and perform other force cost analysis drills. In order to use it, data must be in or able to be converted to the SRC format. The EFCDB is a user friendly version of the data contained in FCM. The Handbook is for the most part a smaller subset of the data contained in the EFCDB made for analysts not primarily working in force costing. The CMRM is a model used to determine the costs involved in using different strategies to decrease civilian personnel spaces. The ESR is a model used to determine the costs involved in using different strategies to decrease military endstrength.

b. CEAC developed FORCES to meet many stringent user requirements and the needs of the Army cost community. The design of the FORCES suite of models and data bases is flexible to accommodate both changes in cost data and Army requirements. FORCES includes all elements necessary to estimate the cost of a force unit. CEAC regularly updates the suite and distributes it to reflect changes in acquisition, operations, transportation, and personnel costs. FORCES also contains the approved TOE force structure for both AC and RC units. The TOE structure represents the unclassified doctrinal structure of the Army vis-à-vis the classified, modified TOE operational structure. The TOE structure allows flexibility in costing notional force units.

c. Analysts can cost force units using FCM which guides the analyst in the preparation of the various types of force cost estimates. In addition, analysts can use the data in the EFCDB to refine data in their own models or to create models for out of the ordinary force costing exercises. FORCES is available for distribution to any level within the Army.

d. Although FORCES provides finished products, the analyst must still use professional judgment. Analysts must always review FORCES results to ensure that estimates fully address the question being asked. Please see Appendix G for the FCM cost element structure and definitions.

APPENDIX A - REFERENCES

Section I - Required Publication

AR 11-18
The Cost and Economic Analysis Program (cited in section 1-1a.)

Section II - Related Publications

A related publication is merely a source of additional information. The user does not have to read it to understand this manual.

Title 10, United States Code, Section 2434
Independent Cost Estimates; Operational Manpower Requirements

DoDD 5000.1
Defense Acquisition

DoD 5000.2-R
Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs

DoDD 5000.4
OSD Cost Analysis Improvement Group (CAIG)

DoD 5000.4-M
Cost Analysis Guidance and Procedures

DoDI 7041.3
Economic Analysis and Program Evaluation for Resource Management

AR 1-1
Planning, Programming, Budgeting, and Execution System

AR 70-1
Army Acquisition Policy

Military Handbook 881 formally MIL-STD-881B
Work Breakdown Structures for Defense Materiel Items

OMB Circular A-76
Performance of Commercial Activities

Appendix A - References

OMB Circular A-94
Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs

OMB Circular A-109
Major System Acquisitions

AMC-P 715-5
Cost/Schedule Control System Criteria Joint Implementation Guide

SARDA Guide for the Preparation of Army Acquisition Programs for Review by the Army Systems Acquisition Review Council (ASARC), November 1996

Defense System Management College
4th Edition, Glossary, Defense Acquisition Acronyms and Terms

APPENDIX B - FIGURES AND TABLES

Figures

Tables

APPENDIX C - COST ANALYSIS TRAINING

Defense Acquisition University

The following courses, available through the Defense Acquisition University, can be used to meet Defense Acquisition Workforce Improvement Act (DAWIA) certification requirements as of FY 1997 for members of the Acquisition Workforce in the Cost Estimating Track.

a.	ACQ 101	Fundamentals of Systems Acquisition Management
b.	ACQ 201	Intermediate Systems Acquisition
c.	BCE 101	Fundamentals of Cost Analysis
d.	BCE 204	Intermediate Cost Analysis
e.	BCE 206	Cost/Risk Analysis
f.	BCE 207	Economic Analysis
g.	BCE 208	Software Cost Estimating
h.	BCF 301	Business Cost Estimating Financial Management Workshop
i.	BFM 102	Contract Performance Management Fundamentals
j.	BFM 201	Systems Acquisition Funds Management
k.	BFM 203	Intermediate Contract Performance Management
l.	BFM 204	Contractor Finance for Acquisition Managers
m.	BFM 209	Selected Acquisition Report Review

Other Sources

The following cost analysis related courses are also available as indicated, but cannot be used to meet Defense Acquisition Workforce Improvement Act (DAWIA) certification requirements for members of the Acquisition Workforce in the Cost Estimating Track.

a. U.S. Army Logistics Management College, Fort Lee, VA
   - (1) ALMC-CC Cost Estimating for Engineers
   - (2) ALMC-DA Decision Risk Analysis

b. U.S. Army Management Engineering College, Rock Island, IL
   - (1) AMEC-292 Activity-Based Costing Principles
   - (2) 7A-F10 Economic Analysis for Decision-Making
   - (3) AMEC-285 Functional Economic Analysis

c. U.S. Air Force Institute of Technology, Wright Patterson AFB, OH
   - (1) CON 104 Contract Pricing
   - (2) QMT 353 Introduction to Life Cycle Costing
   - (3) SYS 362 Cost/Schedule Control Systems Criteria

APPENDIX D - MATERIEL SYSTEMS PME GENERIC WORK BREAKDOWN STRUCTURES

This appendix displays the Level 2, 3, and 4 prime mission equipment (PME) generic work breakdown structure (WBS) elements as adopted for Army aircraft, electronic, missile, and surface vehicle systems. It also shows the Level 2 and 3 PME generic WBS elements for ordnance and space systems. These structures were developed from the MIL-STD-881B, dated 25 March 1993. The cost element structure (appendix E) incorporates all aspects of the WBS Level 2 support elements, such as system engineering/program management, training, data, and peculiar support equipment. This appendix is presented as a guide and may be adapted as necessary for specific weapon systems. However, any changes must conform to the program WBS (reference DoD 5000.2-R, Part 4.4.2B).

A. PME WBS—AIRCRAFT SYSTEMS

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
AIRCRAFT SYSTEM			
	AIR VEHICLE		
		AIRFRAME	
			BASIC STRUCTURE
			AIR INDUCTION
			ALIGHTING GEAR
			FLIGHT CONTROLS
			ELECTRICAL SUBSYSTEM
			ROTOR GROUP
			ENVIRONMENTAL CONTROL SUBSYSTEM
			INTEGRATION, ASSEMBLY, TEST, AND CHECKOUT
			OTHER
		PROPULSION	
			ENGINE
			ROTOR BLADES
			THRUST DEVICES
			TRANSMISSION
			GEAR BOXES
			OTHER
		AIR VEHICLE APPLICATIONS SOFTWARE	
		AIR VEHICLE SYSTEM SOFTWARE	
		COMMUNICATIONS/IDENTIFICATION	
			INTERCOM
			RADIO
			IFF
			INTEGRATED COM/NAV/ID
			OTHER
		NAVIGATION/GUIDANCE	
			RADAR
			DIRECTION FINDING
			COMPUTER
			PILOT NIGHT VISION SYSTEM (PNVS)
			OTHER

CENTRAL COMPUTER

A. PRIME MISSION EQUIPMENT WBS—AIRCRAFT SYSTEMS (CONTINUED)

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
		FIRE CONTROL	
			COMPUTER
			AIR DATA SUBSYSTEM
			CONTROLS AND DISPLAYS
			TARGET ACQUISITION DESIGNATION SIGHT (TADS)
			OTHER
		DATA DISPLAYS AND CONTROLS	
		SURVIVABILITY	
			RECEIVERS
			WARNING DEVICES
			ECM
			OTHER
		RECONNAISSANCE	
			CAMERAS
			ELECTRONICS
			OTHER
		AUTOMATIC FLIGHT CONTROL	
			AUTOMATIC PILOT
			SENSORS
			MECHANICAL AND ELECTRICAL
			OTHER
		CENTRAL INTEGRATED CHECKOUT	
			SENSORS
			DISPLAYS
			OTHER
		ANTISUBMARINE WARFARE	
			SENSORS
			DISPLAYS
			OTHER
		ARMAMENT	
			GUNS
			TURRET
			AMMO FEED MECHANISM
			OTHER
		WEAPONS DELIVERY	
			LAUNCHER
			RACKS AND PYLONS
			OTHER
		AUXILIARY EQUIPMENT	
			ANTENNAE
			CONTROL BOXES
			ENVIRONMENT CONTROL
			FLARES
			OTHER
		OTHER	
	Other		

B. PME WBS—ELECTRONIC/AUTOMATED SOFTWARE SYSTEMS

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
ELECTRONIC/AUTOMATED SOFTWARE SYSTEM			
	PRIME MISSION PRODUCT (PMP)		
		FRONT END (SENSORS)	
			RADOME
			ANTENNA
			TRANSMITTER
			RECEIVER
			OTHER
		PROCESSING (ADPE)	
			CPU
			INTERFACES
			OTHER
		COMMUNICATIONS	
			TRANSMITTER
			RECEIVER
			ANTENNA
			TERMINAL
			RADIO
			MODEMS
			COMSEC
			COMM LINK
			OTHER
		PERIPHERALS	
			MISSION DISPLAYS
			PRINTERS
			DISK DRIVE
			TAPE DRIVE
			OPTICAL DRIVE
			OTHER
		ENVIRONMENTAL SUPPORT	
			POWER SUPPLY
			COOLING/HEATING
			TRANSPORTER
			SECURITY
			SHELTER
			SHELTER MOD
			OTHER
		PMP APPLICATIONS SOFTWARE	
			SOFTWARE
			FIRMWARE
			BITE
			OTHER
		PMP SYSTEM SOFTWARE	
		INTEGRATION, ASSEMBLY, TEST, AND CHECKOUT	
		OTHER	
	PLATFORM INTEGRATION		

OTHER

C. *PME WBS—MISSILE SYSTEMS*

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
MISSILE SYSTEM			
	AIR VEHICLE		
		PROPULSION (STAGES I...N, AS REQUIRED)	
			STAGE I
			STAGE II
			ENGINE
			INTEGRATION, ASSEMBLY, TEST, AND CHECKOUT
			OTHER
		PAYLOAD	
			WARHEAD
			SHROUD
			INTEGRATION, ASSEMBLY, TEST, AND CHECKOUT
			OTHER
		AIRFRAME	
		REENTRY SYSTEM	
		POST BOOST SYSTEM	
		GUIDANCE AND CONTROL	
			GUIDANCE SECTION
			CONTROL SECTION
			SOFTWARE
			INTEGRATION, ASSEMBLY, TEST, AND CHECKOUT
			OTHER
		ORDNANCE INITIATION SET	
		AIRBORNE TEST EQUIPMENT	
		AIRBORNE TRAINING EQUIPMENT	
		AUXILIARY EQUIPMENT	
		INTEGRATION, ASSEMBLY, TEST, AND CHECKOUT	
		OTHER	
	COMMAND AND LAUNCH		
		SURVEILLANCE, IDENTIFICATION, AND TRACKING SENSORS	
		LAUNCH AND GUIDANCE CONTROL	
		COMMUNICATIONS	
		COMMAND AND LAUNCH APPLICATIONS SOFTWARE	
		COMMAND AND LAUNCH SYSTEM SOFTWARE	
		LAUNCHER EQUIPMENT	
			CONTAINER
			LAUNCH VEHICLE/TRANSPORTER
			OTHER
		AUXILIARY EQUIPMENT	
		OTHER	
	OTHER		

D. PME WBS—ORDNANCE SYSTEMS

LEVEL 1	LEVEL 2	LEVEL 3
ORDNANCE SYSTEM		
	COMPLETE ROUND	
		STRUCTURE
		PAYLOAD
		GUIDANCE AND CONTROL
		FUZE
		SAFETY/ARM
		PROPULSION
		INTEGRATION, ASSEMBLY, TEST, AND CHECKOUT
		OTHER
	LAUNCH SYSTEM	
		LAUNCHER
		CARRIAGE
		FIRE CONTROL
		READY MAGAZINE
		ADAPTER KITS
		INTEGRATION, ASSEMBLY, TEST, AND CHECKOUT
		OTHER
	OTHER	

E. PME WBS—SPACE SYSTEMS

LEVEL 1	LEVEL 2	LEVEL 3
SPACE SYSTEM		
	LAUNCH VEHICLE	
		PROPULSION (SINGLE STAGE ONLY)
		STAGE I
		STAGE II...N (AS REQUIRED)
		STRAP-ON UNITS (AS REQUIRED)
		SHROUD (PAYLOAD FAIRING)
		GUIDANCE AND CONTROL
		INTEGRATION, ASSEMBLY, TEST, AND CHECKOUT
		OTHER
	ORBITAL TRANSFER VEHICLE	
		PROPULSION (SINGLE STAGE ONLY)
		STAGE I
		STAGE II...N (AS REQUIRED)
		STRAP-ONS (AS REQUIRED)
		GUIDANCE AND CONTROL
		INTEGRATION, ASSEMBLY, TEST, AND CHECKOUT
		OTHER
	SPACE VEHICLE	
		SPACECRAFT
		PAYLOAD I...N (AS REQUIRED)
		REENTRY VEHICLE
		ORBIT INJECTOR/DISPENSER
		INTEGRATION, ASSEMBLY, TEST, AND CHECKOUT
		OTHER
	GROUND COMMAND, CONTROL, COMMUNICATIONS AND MISSION EQUIPMENT	
		SENSOR I...N, (AS REQUIRED)
		TELEMETRY, TRACKING, AND CONTROL
		EXTERNAL COMMUNICATIONS
		DATA PROCESSING EQUIPMENT
		LAUNCH EQUIPMENT
		AUXILIARY EQUIPMENT
		OTHER
	FLIGHT SUPPORT OPERATIONS AND SERVICES	
		MATE/CHECKOUT/LAUNCH
		MISSION CONTROL
		TRACKING AND C^3
		RECOVERY OPERATIONS AND SERVICES
		LAUNCH SITE MAINTENANCE/REFURBISHMENT
		OTHER
	STORAGE	
		PLANNING AND PREPARATION
		STORAGE
		TRANSFER AND TRANSPORTATION
		OTHER

OTHER

F. PME WBS—SURFACE VEHICLE SYSTEMS

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
SURFACE VEHICLE SYSTEM			
	PRIMARY VEHICLE		
		HULL/FRAME	
			STRUCTURE
			ACCOMMODATIONS FOR SUBSYSTEM
			TOWING AND LIFTING FITTINGS
			BUMPERS
			HATCHES
			GRILLES
			SUSPENSION MOUNTINGS
			OTHER
		SUSPENSION/STEERING	
			WHEELS
			TRACKS
			STEERING GEARS
			RUDDER THRUST DEVICES
			TRIM VANES
			SPRINGS
			SHOCKS ABSORBERS
			SKIRTS
			OTHER
		POWER PACKAGE/DRIVE TRAIN	
			ENGINE
			ENGINE-MOUNTED AUXILIARIES
			AIR DUCTING
			MANIFOLDS
			CONTROLS AND INSTRUMENTATION
			EXHAUST SYSTEMS
			COOLING MEANS
			TRANSMISSION
			CLUTCHES
			SHAFT ASSEMBLIES
			TORQUE CONVERTERS
			DIFFERENTIALS
			FINAL DRIVES
			POWER TAKEOFFS
			INTEGRAL BRAKES AND STEERING
			OTHER
		AUXILIARY AUTOMOTIVE	
			VEHICLE ELECTRICAL SYSTEM
			FIRE EXTINGUISHER SYSTEM
			CONTROLS
			CHASSIS-MOUNTED ACCESSORIES
			WINCH AND POWER TAKEOFF
			TOOLS AND EQUIPMENT

ON-VEHICLE MATERIALS

F. PRIME MISSION EQUIPMENT WBS—SURFACE VEHICLE SYSTEMS (CONTINUED)

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
			OTHER
		TURRET ASSEMBLY	
			ARMOR
			ATTACHMENTS AND APPENDAGES
			HATCHES
			CUPOLAS
			TURRET ELECTRICAL SYSTEM
			PERSONNEL ACCOMMODATIONS
			COMMAND AND CONTROL
			OTHER
		FIRE CONTROL	
			RADARS
			SENSORS
			RENDEZVOUS AND CTR TRACKING
			DISPLAYS
			SIGHTS OR SCOPES
			COMPUTER
			SOFTWARE
			OTHER
		ARMAMENT	
			MAIN GUN
			LAUNCHERS
			SECONDARY ARMAMENT
			OTHER
		BODY/CAB	
			PERSONNEL ACCOMMODATIONS
			CARGO
			PLACEMENT OF SUBSYSTEMS
			OTHER
		AUTOMATIC LOADING	
		AUTOMATIC/REMOTE PILOTING	
		NUCLEAR, BIOLOGICAL, CHEMICAL	
		SPECIAL EQUIPMENT	
			WRECKER EQUIPMENT
			RECOVERY VEHICLES
			FIELD WORK UNITS
			FURNISHING AND EQUIPMENT
			OTHER
		NAVIGATION	
		COMMUNICATIONS	
		INTEGRATION, ASSEMBLY, TEST, AND CHECKOUT	
			INTERFACE SECTIONS/MATERIAL
			OTHER
		OTHER	
	SECONDARY VEHICLE		
		(SAME AS ABOVE)	
	OTHER		

APPENDIX E - COST ELEMENT STRUCTURE AND DEFINITIONS

Section I - Cost Element Structure

1.0 RESEARCH, DEVELOPMENT, TEST, AND EVALUATION (RDT&E)-FUNDED ELEMENTS

1.01	DEVELOPMENT ENGINEERING*
1.02	PRODUCIBILITY ENGINEERING AND PLANNING (PEP)*
1.03	DEVELOPMENT TOOLING*
1.04	PROTOTYPE MANUFACTURING*
1.05	SYSTEM ENGINEERING/PROGRAM MANAGEMENT
1.051	PROJECT MANAGEMENT ADMINISTRATION (PM CIV/MIL)
1.052	OTHER
1.06	SYSTEM TEST AND EVALUATION
1.07	TRAINING
1.08	DATA
1.09	SUPPORT EQUIPMENT
1.091	PECULIAR
1.092	COMMON
1.10	DEVELOPMENT FACILITIES
1.11	OTHER RDT&E

2.0 PROCUREMENT-FUNDED ELEMENTS

2.01	NONRECURRING PRODUCTION
2.011	INITIAL PRODUCTION FACILITIES (IPFs)*
2.012	PRODUCTION BASE SUPPORT (PBS)*
2.013	OTHER NONRECURRING PRODUCTION*
2.02	RECURRING PRODUCTION
2.021	MANUFACTURING*
2.022	RECURRING ENGINEERING*
2.023	SUSTAINING TOOLING*
2.024	QUALITY CONTROL*
2.025	OTHER RECURRING PRODUCTION*
2.03	ENGINEERING CHANGES*
2.04	SYSTEM ENGINEERING/PROGRAM MANAGEMENT
2.041	PROJECT MANAGEMENT ADMINISTRATION (PM CIV/MIL)
2.042	OTHER
2.05	SYSTEM TEST AND EVALUATION, PRODUCTION
2.06	TRAINING
2.07	DATA
2.08	SUPPORT EQUIPMENT
2.081	PECULIAR
2.082	COMMON

* These elements should be further subdivided to reflect the MIL-STD-881B Level 3 prime mission equipment WBS elements. Greater level of detail is permissible.

2.09	OPERATIONAL/SITE ACTIVATION
2.10	FIELDING
2.101	INITIAL DEPOT-LEVEL REPARABLES (SPARES)
2.102	INITIAL CONSUMABLES (REPAIR PARTS)
2.103	INITIAL SUPPORT EQUIPMENT
2.104	TRANSPORTATION (EQUIPMENT TO UNIT)
2.105	NEW EQUIPMENT TRAINING (NET)
2.106	CONTRACTOR LOGISTICS SUPPORT
2.11	TRAINING AMMUNITION/MISSILES
2.12	WAR RESERVE AMMUNITION/MISSILES
2.13	MODIFICATIONS
2.14	OTHER PROCUREMENT

3.0 MILITARY CONSTRUCTION (MC)-FUNDED ELEMENTS

3.01	DEVELOPMENT CONSTRUCTION
3.02	PRODUCTION CONSTRUCTION
3.03	OPERATIONAL/SITE ACTIVATION CONSTRUCTION
3.04	OTHER MC

4.0 MILITARY PERSONNEL (MP) DIRECT-FUNDED ELEMENTS (not reimbursed by any other appropriation)

4.01	CREW
4.02	MAINTENANCE (MTOE)
4.03	SYSTEM-SPECIFIC SUPPORT
4.04	SYSTEM ENGINEERING/PROGRAM MANAGEMENT
4.041	PROJECT MANAGEMENT ADMINISTRATION (PM MIL)
4.042	OTHER
4.05	REPLACEMENT PERSONNEL
4.051	TRAINING
4.052	PERMANENT CHANGE OF STATION (PCS)
4.06	OTHER MP

5.0 OPERATIONS AND MAINTENANCE (O&M)-FUNDED ELEMENTS

5.01	FIELD MAINTENANCE CIVILIAN LABOR**
5.02	SYSTEM-SPECIFIC BASE OPERATIONS
5.03	REPLENISHMENT DEPOT-LEVEL REPARABLES (SPARES)**
5.04	REPLENISHMENT CONSUMABLES (REPAIR PARTS)**
5.05	PETROLEUM, OIL, AND LUBRICANTS (POL)**
5.06	END-ITEM SUPPLY AND MAINTENANCE
5.061	OVERHAUL (P7M)
5.062	INTEGRATED MATERIEL MANAGEMENT
5.063	SUPPLY DEPOT SUPPORT
5.064	INDUSTRIAL READINESS
5.065	DEMILITARIZATION
5.07	TRANSPORTATION
5.08	SOFTWARE

** These elements should be further subdivided to reflect the MIL-STD-881B Level 2 prime mission equipment WBS elements and the support equipment element. Greater level of detail is permissible.

5.09	SYSTEM TEST AND EVALUATION, OPERATIONAL
5.10	SYSTEM ENGINEERING/PROGRAM MANAGEMENT
5.101	PROJECT MANAGEMENT ADMINISTRATION (PM CIV)
5.102	OTHER
5.11	TRAINING
5.12	OTHER O&M

6.0 ARMY WORKING CAPITAL FUND (AWCF) ELEMENT

6.01	AWCF CLASS IX WAR RESERVES

Section II - Cost Element Definitions

1.0 RESEARCH, DEVELOPMENT, TEST, AND EVALUATION (RDT&E)-FUNDED ELEMENTS

All RDT&E-funded costs associated with the research and development (R&D) of the materiel system, including development costs for system armament, training devices, ammunition, missiles, and modifications.

1.01 DEVELOPMENT ENGINEERING

This element includes the costs of study, analysis, design development, evaluation, testing, and redesign for the system component(s) during the system development efforts. It includes the design efforts of preparing specifications, engineering drawings, parts lists, wiring diagrams, test planning and scheduling, analysis of test results, data reduction, report preparations and establishment of reliability, maintainability, and quality assurance control requirements. It also includes the costs of raw and semi-fabricated material plus purchased parts consumed in the performance of component engineering efforts. Also included is engineering test equipment such as oscilloscopes, transducers, recorders, radio transmitters, converters, discriminators, receivers, and other equipment required to accomplish the engineering function for the specified system components. This element also includes the engineering efforts in support of preplanned product improvements and development costs for any neutralization process designed to change the physical, chemical, biological character or composition of hazardous waste produced by the system. Excluded from this element are the engineering efforts (producibility engineering and planning) to ensure producibility of the item or system prior to quantity procurement.

1.02 PRODUCIBILITY ENGINEERING AND PLANNING (PEP)

This element includes the costs of ensuring the producibility of the developmental materiel system, item, or component. PEP involves the engineering tasks necessary to ensure timely, efficient, and economic production of essential materiel and is primarily of a planning nature. PEP includes efforts related to development of the Technical Data Package (TDP), quality assurance (QA) plans, and special production processes to assess producibility. Also included are the development of unique processes essential to the design and manufacture of the materiel and details of performance ratings dimensional and tolerance data; manufacturing assembly; sequences; schematics; mechanical and electrical connections; physical characteristics, including form, fit, and finishes; inspection test and evaluation requirements; calibration information; and quality control procedures.

1.03 DEVELOPMENT TOOLING

This element includes the costs of planning, design, fabrication, assembly, installation, modification, maintenance, and rework of all tools, inspection equipment, and test equipment supporting the development of a specified system component. It includes that time expended in determining tool, inspection, and test equipment requirements; planning of fabrication and testing operations; maintaining tool records; scheduling and control of all tools orders; and programming and preparing software for all numerically controlled machine tools used in development of a system component. It includes the costs of new materials used in the fabrication, assembly, installation, modification, and maintenance and rework of dies, jigs, fixtures, inspection equipment, handling equipment, work platforms, and test equipment used to develop each system component, as well as tools normally purchased in final form or that require negligible effort to assemble.

1.04 PROTOTYPE MANUFACTURING

This element includes the costs of fabrication, processing, subassembly, final assembly, reworking modification, and installation of parts and equipment, power plants, boosters, electronic equipment, explosives, and other items (including Government-Furnished equipment [GFE]), and the proving of such equipment and instruments for the specified system prototype element. This includes the construction of piece parts from raw materials—the cutting, forming, stretching, and blanking operations performed on materials to make individual parts. It includes bench assembling of all minor and major assemblies; mating or joining of primary sections; installation of special and general equipment, instruments, and accessories performed after the mating; and all other preparation and/or processing and preflight and production service operations. Also included are the raw and semi-fabricated material plus purchased parts used in the manufacture of the specified system prototype item. The costs of prototype spare assemblies and parts are also included within this element.

1.05 SYSTEM ENGINEERING/PROGRAM MANAGEMENT

1.051 PROJECT MANAGEMENT ADMINISTRATION (PM CIV/MIL)

This element includes the RDT&E-funded costs of the PM's office (civilian and military reimbursement) for system engineering and technical control, as well as the business management of the system/program. It encompasses the overall planning, direction, and control of the definition, development, and production of the system/program, including functions of logistics engineering and integrated logistics support (ILS) management, e.g., maintenance support, facilities, personnel, training, testing, and activation of a system. System engineering/ management efforts that can be associated specifically with the individual hardware elements are excluded. This element includes any RDT&E reimbursement to MP for military personnel costs associated with project management in the PM's office. Also included are any PM office RDT&E-funded costs to manage and administer environmental efforts, e.g., PM environmental management team, and compliance with the National Environmental Policy Act (NEPA) and the National Aerospace Standard (NAS) 411 for pollution prevention plans.

1.052 OTHER

This element includes the costs of any other RDT&E-funded costs for system engineering and technical control, as well as the business management of the system/program. It encompasses the overall planning, direction, and control of the definition, development, and production of the system/program, including functions of logistics engineering and ILS management, e.g., maintenance support, facilities, personnel, training, testing, and activation of a system. System engineering/ management effort that can be associated specifically with the individual hardware elements is excluded. This element also includes any RDT&E reimbursement to MP for military personnel costs associated with project management not in the PM's office.

1.06 SYSTEM TEST AND EVALUATION

This element includes the RDT&E-funded costs of system-related test activities, including costs of specially fabricated hardware to obtain or validate engineering data on the performance of the system. This element also includes costs of the detailed planning, conduct, support, data reduction, and reports from such testing, as well as hardware items that are consumed or planned to be consumed in the conduct of such operations. This element includes the testing of innovative pollution prevention technologies and neutralization processes as well as the costs of any hazardous, toxic, or radiological materials used during system test and evaluation. Also included are the costs of all efforts associated with the design, production, and disposal of models, specimens, fixtures, and instrumentation in support of the test program. The actual test articles (i.e., functionally configured systems) are excluded from this element; they were included in the element prototype manufacturing. Also excluded is all testing that is O&M-funded. Testing that can be associated with a subsystem (e.g., aircraft engine) is included in the costs of that subsystem, rather than this system-oriented cost element.

1.07 TRAINING

This element includes the costs of services, devices, accessories, aids, equipment, facilities, and parts used to facilitate instructions through which personnel acquire sufficient concepts, skills, and aptitudes to operate and maintain the system with maximum efficiency. This element includes costs of efforts associated with the design, development, and production of prototype training equipment, and the execution of training services. It includes the RDT&E costs of training initial service test crews and maintenance personnel, including temporary duty of Government personnel, involved in the testing including training needed on handling hazardous materials and proper use of personal protection equipment.

1.08 DATA

This element includes the costs of preparation, revision, and reproduction of drawings, specifications, parts lists, test plans, testing procedures, draft manuals, environmental reports, and other documentation that are produced in support of project management, engineering, tooling fabrication, and testing functions. Relative to a contract, this element includes costs of all deliverable data listed on a DD Form 1423, i.e., such efforts as can be reduced or eliminated with reductions or elimination of the listed requirements. If the data are Government peculiar, include the efforts of acquiring, writing, assembling, reproduction, etc. If the data are not Government peculiar, but are identical to that used by the contractor except in a different format, include costs of such efforts as reproduction, packaging, shipping, and, if necessary, reformatting.

1.09 SUPPORT EQUIPMENT

1.091 PECULIAR

This element includes the costs of the design and development of those deliverable items and associated software required to support and maintain the system or portions of the system while not directly engaged in the performance of its mission, and that have application peculiar to the given system. It includes, for example, vehicles, equipment, tools, etc., unique to the system used to fuel, service, transport, hoist, repair, overhaul, assemble, disassemble, test, inspect, or otherwise maintain the mission equipment.

1.092 COMMON

This element includes the costs of the design and development of those deliverable items and associated software required to support and maintain the system or portions of the system while not directly engaged in the performance of its mission, and that have application common to other than the given system. It includes, for

example, vehicles, equipment, tools, etc., not unique to the system used to fuel, service, transport, hoist, repair, overhaul, assemble, disassemble, test, inspect, or otherwise maintain the mission equipment.

1.10 DEVELOPMENT FACILITIES

This element includes the RDT&E-funded costs of any new building, conversion or expansion of facilities or sites, and the acquisition of real estate for development and testing of the system. This includes those RDT&E-funded costs for facilities to handle or store hazardous materials or waste including underground storage tanks. It also includes any RDT&E funded construction costs for modification and testing of systems already in the Army inventory if necessary to the furtherance of the R&D program.

1.11 OTHER RDT&E

This element includes any RDT&E-funded costs not included in the previous elements. Costs must be system specific and clearly identified.

2.0 PROCUREMENT-FUNDED ELEMENTS

All procurement-funded costs resulting from the production and introduction of the materiel into the Army's operational inventory. This includes:

(1) All costs to the Government, defined as contractor costs plus in-house costs, of products and services necessary to transform the results of development into a fully operational system consisting of the hardware, training, and support activities necessary to initiate operations.

(2) Costs of both a nonrecurring (i.e., costs that are required to establish a production capability) and recurring nature (i.e., costs that occur repeatedly during production and delivery to user organizations).

(3) All costs resulting from production and introduction into inventory irrespective of how allocated, e.g., unit equipment (UE), maintenance float (MF), war reserve (WR), and training usage classification.

2.01 NONRECURRING PRODUCTION

2.011 INITIAL PRODUCTION FACILITIES (IPFs)

This element includes the cost of the initial hard tooling and production line set up to support low-rate and full-scale production of the system; and the cost of fabrication, assembly, and installation of tools (including modification and rework of development tools for production purposes), dies, templates, patterns, form block manufacture, jigs, fixtures, master forms, inspection equipment, handling equipment, load bars, work platforms (including installation of utilities thereon), and test equipment (such as checkers and analyzers) to support the manufacture of the specified system. It includes initial and duplicate sets of tools necessary to reach full-rate production plus modification of LRIP tool records, establishment of make-or-buy and manufacturing plans on nonrecurring tools and equipment, scheduling and control of tool orders, and programming and preparation of software for numerically controlled machine equipment. Included in this element are any provision of industrial facilities (PIF), depot maintenance plant equipment (DMPE), and layaway of industrial facilities that are system specific.

2.012 PRODUCTION BASE SUPPORT (PBS)

This element includes the procurement-funded costs of construction, conversion, or expansion of facilities for production, inventory, or maintenance required to accomplish the program. These costs may be identified with either or both the contractor and in-house efforts. They may be identified with the total system or with specific components of the total system, such as the engine. This element excludes any PIF costs included in IPFs.

2.013 OTHER NONRECURRING PRODUCTION

This element includes any procurement-funded, nonrecurring production costs not included in the above subelements. Costs must be system specific and clearly identified. For example, disposal, demilitarization, or layaway costs of Government-owned production equipment should be included here as a cost to the system.

2.02 RECURRING PRODUCTION

2.021 MANUFACTURING

This element includes the costs of material, labor, and other expenses incurred in the fabrication, checkout, and processing of parts, subassemblies, and major assemblies/subsystems needed for the final system. This element also includes Government-furnished equipment and material, as well as costs of subcontractors and purchased parts/equipment. The element further includes costs of the efforts to integrate and assemble the various subassemblies into a working system, costs to install special and general equipment, costs to paint and package the system for shipment to its acceptance destination, and costs associated with preplanned product improvements. It also includes moves in order to assemble into a final system.

2.022 RECURRING ENGINEERING

This element includes the costs of all engineering efforts performed in support of production, including maintainability/reliability engineering, maintenance engineering, value engineering, and production engineering costs associated with the system. It also includes redesign, evaluation, and other support engineering efforts (either in-house, contract, or separate contractor) directly involved with production of the components/end item, e.g., maintenance of the TDP, preparation of engineering change proposals (ECPs), engineering change orders (ECOs), and analysis of test results.

2.023 SUSTAINING TOOLING

This element includes the costs of maintenance replacement or modification of tools and test equipment after the start of production. It includes the replacement of initial tools that break down, and modification, maintenance, and rework of initial and duplicate sets of tools occurring after production begins.

2.024 QUALITY CONTROL

This element includes the costs of implementing controls necessary to ensure that a manufacturing process produces a system that meets the prescribed standards. Included are costs of receiving, in-process, and final inspections of tools, parts, subassemblies, and complete assemblies. It also includes such tasks as reliability testing, establishment of acceptable quality levels (AQLs), statistical methods for determining performance of manufacturing processes, preparation and review of reports relating to these tasks, stockpile reliability testing, and the performance of production acceptance tests (PATs).

2.025 OTHER RECURRING PRODUCTION

This element includes any procurement-funded, recurring production costs not included in the above subelements. Costs must be system specific and clearly identified, e.g., warranty cost for a specific item.

2.03 ENGINEERING CHANGES

This element includes the costs of official alterations made to a system while it is still in the manufacturing process (before acceptance by the Army). Modifications that change the performance of the system or done after the system is accepted by the Army will be costed in modifications.

2.04 SYSTEM ENGINEERING/PROGRAM MANAGEMENT

2.041 PROJECT MANAGEMENT ADMINISTRATION (PM CIV/MIL)

This element includes the procurement-funded costs of the PM's office (civilian and military reimbursement) for system engineering and technical control, as well as the business management of the system/program. It encompasses the overall planning, direction, and control of the definition, development, and production of the system/program, including functions of logistics engineering and ILS management, e.g., maintenance support, facilities, personnel, training, testing, and activation of a system. System engineering/ management efforts that can be associated specifically with the individual hardware elements are excluded. This element also includes any procurement reimbursement to MP for military personnel costs associated with project management in the PM's office. Also included are any PM office procurement-funded costs to manage and administer environmental efforts, e.g., PM environmental management team, and compliance with the National Environmental Policy Act (NEPA) and the National Aerospace Standard (NAS) 411 for pollution prevention plans.

2.042 OTHER

This element includes the costs of any other procurement-funded costs for system engineering and technical control as well as the business management of the system/program. It encompasses the overall planning, direction, and control of the definition, development, and production of the system/program, including functions of logistics engineering and ILS management, e.g., maintenance support, facilities, personnel, training, testing, and activation of a system. System engineering/ management effort that can be associated specifically with the individual hardware elements is excluded. This element also includes any procurement reimbursement to MP for military personnel costs associated with project management not in the PM's office.

2.05 SYSTEM TEST AND EVALUATION, PRODUCTION

This element includes the procurement-funded costs of the system-related production test activities that are identifiable with the evaluation of the system. Included are the costs of hardware to obtain or validate data. Also included are the costs of the planning, conduct, support, data reduction, and reports from such testing and test items consumed in the conduct of such operations, as well as the costs of design, production, handling, storage, and disposal of models, specimens, fixtures, instrumentation, and hazardous materials or waste in support of the test program. Articles for testing that are complete production units should be costed under recurring production.

2.06 TRAINING

This element includes the system-specific, procurement-funded costs of training devices, accessories, aids, equipment, facilities, and parts used to facilitate instruction through which personnel will acquire sufficient concepts, skills, and aptitudes to operate and maintain the system with maximum efficiency. This element includes costs for the efforts associated with the production and fielding of training equipment.

2.07 DATA

This element includes the procurement-funded costs of gathering, storing, reproducing, and disseminating system-specific technical, environmental, and managerial supportability data, and the cost of preparing, updating, and reproducing publications such as technical orders, handbooks, and field manuals during production. Relative to a contract, this element includes costs of all deliverable data listed on a DD Form 1423. This element includes only such efforts that can be reduced or will not be incurred if the data item is eliminated. If the data are Government peculiar, include the efforts of acquiring, writing assembling, and reproduction. If the data are not Government peculiar, but are identical to that used by the contractor, except in a different format, include costs of such efforts as reproduction, packaging, shipping, and, if necessary, reformatting.

2.08 SUPPORT EQUIPMENT

2.081 PECULIAR

This element includes the costs of the production of those deliverable items and associated software required to support and maintain the system or portions of the system while not directly engaged in the performance of its mission, and that have application peculiar to the given system. It includes, for example, vehicles, equipment, tools, etc., unique to the system used to fuel, service, transport, hoist, repair, overhaul, assemble, disassemble, test, inspect, or otherwise maintain the mission equipment. Excluded are any initial support equipment costs.

2.082 COMMON

This element includes the costs of the production of those deliverable items and associated software required to support and maintain the system or portions of the system while not directly engaged in the performance of its mission, and that have application common to other than the given system. It includes, for example, vehicles, equipment, tools, etc., not unique to the system used to fuel, service, transport, hoist, repair, overhaul, assemble, disassemble, test, inspect, or otherwise maintain the mission equipment. Excluded are any initial support equipment costs.

2.09 OPERATIONAL/SITE ACTIVATION

This element includes the procurement-funded costs of real estate, construction, conversion, utilities, and equipment to provide all facilities required to house, service, and/or launch prime mission equipment at the organizational and intermediate levels. This element includes the conversion of site, ship, and vehicle; and system assembly, checkout, and installation into the site facility to achieve operational status. It also includes contractor support in relation to operational/site activation. This element also includes the procurement reimbursement costs for system-specific initial base operations (BASOPS)/real property maintenance activities (RPMA)—such as utilities, repair of real property, minor construction, fire prevention, supply operations, maintenance of materiel, and transportation—for site activation equipment installation and one-time BASOPS. Excluded from this element are any MC-funded efforts under operational/site activation construction or O&M-funded efforts under transportation, system testing and evaluation, training, or system-specific base operations.

2.10 FIELDING

2.101 INITIAL DEPOT-LEVEL REPARABLES (SPARES)

This element includes the procurement costs for initial spare components, assemblies, and subassemblies (reparable items) necessary to fill initial ASL/PLL stockage to support end-item fielding throughout the system life cycle. It includes any purchases from the AWCF for reparables. However, any items costed as part of manufacturing should be excluded here, such as engines.

2.102 INITIAL CONSUMABLES (REPAIR PARTS)

This element includes the procurement costs for consumables necessary to fill initial ASL/PLL stockage to support end-item fielding. It includes any purchases from the AWCF for consumables. This element also includes consumable (nonreparable) individual parts, assemblies, or subassemblies required to support end-item fielding. It excludes consumables used in depot maintenance overhaul, repair, or modifications covered in redistribution of displaced equipment.

2.103 INITIAL SUPPORT EQUIPMENT

This element includes the procurement-funded, one-time, system-specific fielding costs (both labor and material) for special equipment, tools, deprocessing of new equipment, and those fielding costs associated with post-production software support (PPSS) that were not funded by RDT&E. Normally, initial support equipment is packaged with equipment end items prior to delivery of the equipment to Army units.

2.104 TRANSPORTATION (FIRST DESTINATION) (FDT)

This element includes only the procurement-funded costs of moving materiel from the manufacturer to the first point of acceptance, receipt or storage point by the Government. This represents a portion of a total system cost. FDT includes transportation costs for shipments which may be interrupted for test or modification before acceptance. Included are such costs as temporary duty (TDY) of crews from duty station to manufacturing plant, to delivery point, and return to duty station; supplies, minor repairs, and fuel during delivery; transporting hazardous materials; and other costs. Excluded are transportation costs paid by a vendor as prescribed in procurement contracts for manufacturing, as well as all one-time costs of retrograding equipment that is being replaced by the materiel system.

2.105 NEW EQUIPMENT TRAINING (NET)

This element includes the system-specific, procurement-funded costs of training services for new equipment training through which personnel will acquire sufficient concepts, skills, and aptitudes to operate and maintain the system with maximum efficiency. It includes the costs for TDY of Government personnel, of training initial-service test crews, maintenance personnel, instructors, initial crew, maintenance personnel and NET teams, as well as the one-time cost of establishing system-specific individual training programs, including all services and manuals. It excludes the costs of replacement training.

2.106 CONTRACTOR LOGISTICS SUPPORT

This element includes the procurement-funded contractor support when introducing a new materiel system. It includes all contractor-provided support required to field and maintain the system until normal maintenance procedures are established and assumed by the unit receiving the new equipment.

2.11 TRAINING AMMUNITION/MISSILES

This element includes the costs of ammunition and missiles consumed by the system being costed (e.g., an aircraft or a tank) during both unit training and annual service practice. The cost of ammunition and/or missiles consumed during the training of replacement personnel, along with the procurement cost of replacement equipment, is included in this cost element. It excludes the MP associated with replacement training and the O&M-funded training services cost.

2.12 WAR RESERVE AMMUNITION/MISSILES

This element includes the costs of war reserve (WR) ammunition/missiles required to sustain combat operations of approved forces through the prescribed period. WR ammunition includes basic load. This element includes all system-specific WR ammunition and basic load.

2.13 MODIFICATIONS

This element includes the procurement-funded costs of the labor and material associated with any approved alteration made to a system by accomplishing a Modification Work Order (MWO), retrofit, conversion, remanufacture, or engineering change after fielding by the Army. It excludes modifications that require a Milestone IV Decision Review, as well as the MP-funded labor costs for installation of these modifications.

2.14 OTHER PROCUREMENT

This element includes any procurement-funded costs not included in the above elements. The costs must be system specific and clearly identified. This element may include any procurement-funded services to address environmental litigation and liabilities.

3.0 MILITARY CONSTRUCTION (MC)-FUNDED ELEMENTS

Military construction projects associated with a materiel system are defined as either system specific or **not** system specific. System-specific requirements and projects are defined as those that meet the following test:

(1) The materiel system cannot be fielded without the construction; and

(2) The need for the construction is generated by the decision to acquire and field a given materiel system or, conversely, if and when a materiel system acquisition is terminated prior to fielding, the need for the

construction ceases and the construction project is automatically canceled along with materiel system program; and

(3) Stationing and organizational requirements such as barracks, dining facilities, unit headquarters building, and the like oriented toward forces' support will be excluded from materiel system cost estimates, unless approved for inclusion as an exception to policy. An example of an exception that would be system specific is the construction of a new fielding location not contiguous to an existing Government facility, i.e., basic site construction for PATRIOT.

Examples of system-specific construction projects are simulator buildings, missile bunkers, and billets associated with the fielding of new organizations for the new systems. All other military construction projects related to the materiel system, either directly or indirectly, are not considered system specific.

3.01 DEVELOPMENT CONSTRUCTION

This element includes only the MC-funded costs of any new building, conversion or expansion of facilities or sites, and acquisition of real estate for development and testing of the system. It includes any construction costs for modification and testing of systems already in the Army inventory if necessary to the furtherance of the development program. This element also includes any MC-funded environmental remediation costs for preparation and cleanup of structures and real estate before, during, and after system specific development or testing.

3.02 PRODUCTION CONSTRUCTION

This element includes only the MC-funded costs of real estate, construction, conversion, utilities, and equipment to achieve initially the total production capability for the materiel system. This includes planning, acquisition of real estate, minor construction, and other MC-funded supporting activities. This element also includes any MC-funded environmental remediation costs for preparation and cleanup of structures and real estate before initial total production capability is achieved.

3.03 OPERATIONAL/SITE ACTIVATION CONSTRUCTION

This element includes only the MC-funded costs of real estate, construction, conversion, environmental remediation, utilities, and equipment to provide all facilities required to house, service, and/or launch prime mission equipment at the organizational and intermediate level. This element includes planning, acquisition of real estate, minor construction, and other MC-funded supporting activities.

3.04 OTHER MC

This element includes any MC costs not included in the previous elements. The costs must be system specific and clearly identified.

4.0 MILITARY PERSONNEL (MP) DIRECT-FUNDED ELEMENTS (not reimbursed by any other appropriation)

This element includes all MP-funded costs associated with the development, production, fielding, operation and support of the materiel system not reimbursed by any other appropriation.

4.01 CREW

This element includes the costs of base pay and allowances, theater costs, and special pay of military personnel whose primary function is to operate the materiel system being costed. Excluded are the costs of those who operate other equipment in the force unit such as trucks and switchboards.

4.02 MAINTENANCE (MTOE)

This element includes the costs of base pay and allowance, theater costs, and special pay of those direct and general support military personnel below depot level whose primary function is to maintain the materiel system being costed. Excluded are the costs of those persons whose primary function is to maintain other equipment in the force unit such as trucks and switchboards.

4.03 SYSTEM-SPECIFIC SUPPORT

This element includes the costs of base pay and allowances, theater costs, and special pay of all military personnel below depot level who are charged to the materiel system and who are not crew or maintenance. It includes the costs of persons in those units (battalions, companies, or attached platoons) that exist only because of the system being costed. Examples of persons who might be included are a company commander, a switchboard operator, a truck driver, a truck repairman, a fuel handler, and an ammunition handler.

4.04 SYSTEM ENGINEERING/PROGRAM MANAGEMENT

4.041 PROJECT MANAGEMENT ADMINISTRATION (PM MIL)

This element includes the MP-funded costs of the PM's office (not reimbursed by the RDT&E or procurement appropriations.) For system engineering and technical control, as well as the business management of the system/program. It encompasses the overall planning, direction, and control of the definition, development, and production of the system/program, including functions of logistics engineering and ILS management, e.g., maintenance support, facilities, personnel, training, testing, and activation of a system. This element excludes any RDT&E or procurement reimbursement to MP for military personnel costs associated with project management in the PM's office. Also included are any PM office MP-funded costs to manage and administer environmental efforts, e.g., PM environmental management team, and compliance with the National Environmental Policy Act (NEPA) and the National Aerospace Standard (NAS) 411 for pollution prevention plans.

4.042 OTHER

This element includes any other MP-funded costs for system engineering and technical control, as well as the business management of the system/program. It encompasses the overall planning, direction, and control of the definition, development, and production of the system/program, including functions of logistics engineering and ILS management, e.g., maintenance support, facilities, personnel, training, testing, and activation of a system. This element excludes any RDT&E or procurement reimbursement to MP for military personnel costs associated with project management not in the PM's office.

4.05 REPLACEMENT PERSONNEL

4.051 TRAINING

This element includes the MP-funded costs of all pay and allowances for the system-specific replacement personnel undergoing formal training for future assignment to the given materiel system. It also includes the pay and allowances of the instructors for the replacement personnel training.

4.052 PERMANENT CHANGE OF STATION (PCS)

This element includes the MP-funded costs associated with the permanent change of station of system-specific replacement personnel to and from overseas theaters and within CONUS.

4.06 OTHER MP

This element includes any MP-funded costs not included in the previous elements. Costs must be system specific and clearly identified.

5.0 OPERATIONS AND MAINTENANCE (O&M)-FUNDED ELEMENTS

All O&M-funded costs associated with the development, production, fielding, operation, and support of the materiel system.

5.01 FIELD MAINTENANCE CIVILIAN LABOR

This element includes the costs of civilian maintenance labor at any level below depot maintenance. It includes contractor performed DS/GS maintenance costs. It excludes civilian labor at the depot.

5.02 SYSTEM-SPECIFIC BASE OPERATIONS

This element includes the O&M-funded costs of system-specific initial BASOPS/RPMA—such as utilities, repair of real property, environmental remediation, minor construction, fire prevention, supply operations, maintenance of materiel, and transportation—for site activation equipment installation and one-time BASOPS. Excluded from this element are any O&M-funded efforts under system test and evaluation, training, transportation, or software.

5.03 REPLENISHMENT DEPOT-LEVEL REPARABLES (SPARES)

This element includes the consumer's O&M costs of purchasing from the AWCF reparables required to resupply initial stockage. It also includes the repairable individual parts, assemblies, or subassemblies required on a recurring basis for the repair of major end items of equipment (including PME and support equipment) subsequent to fielding.

5.04 REPLENISHMENT CONSUMABLES (REPAIR PARTS)

This element includes the consumer's O&M costs of purchasing from the AWCF consumables required to resupply initial stockage. It also includes the consumable (nonreparable) individual parts, assemblies, or subassemblies required on a recurring basis for the repair of major end items of equipment (including PME and support equipment) subsequent to fielding.

5.05 PETROLEUM, OIL, AND LUBRICANTS (POL)

This element includes the costs of fuel, oil, and lubricants for the system.

5.06 END-ITEM SUPPLY AND MAINTENANCE

5.061 OVERHAUL (P7M)

This element includes the costs of material, labor, and overhead for the repair/overhaul of the basic end item and associated components including any compliance costs associated with hazardous materials or waste. The material, labor and overhead costs for contractor-performed depot overhaul are also included in this element.

5.062 INTEGRATED MATERIEL MANAGEMENT

This element includes central supply and maintenance activities conducted in support of end-item distribution, disposal, requirements determination, requisition processing, stock control, WR requirements, cataloging, weapons systems management, weapon systems supply support, provisioning, budgeting/ funding, allowances, configuration management, technical support, and maintenance management. It excludes conventional ammunition and secondary-item integrated materiel management.

5.063 SUPPLY DEPOT SUPPORT

This element includes operations at supply depots, manpower, peculiar support equipment, necessary facilities, and associated costs directly identifiable to end-item supply operations including any compliance costs associated with hazardous materials or waste. It excludes conventional ammunition and secondary-item supply depot operations.

5.064 INDUSTRIAL READINESS

This element includes manpower authorizations, peculiar and support equipment, necessary facilities, environmental compliance, and other associated costs specifically identifiable to management of end-item industrial preparedness activities.

5.065 DEMILITARIZATION

This element includes manpower authorizations, peculiar and support equipment, necessary facilities, and associated costs specifically identifiable to end-item demilitarization activities.

5.07 TRANSPORTATION (SECOND DESTINATION)

This element includes the O&M-funded costs for movement of Army supplies and equipment worldwide, after receipt from production or either a CONUS port, CONUS depot, or CONUS Customer. This includes, but not limited to delivery of new equipment to units (except first destination transportation), direct equipment redistribution, TOE equipment moves on direct unit PCS, and transporting items to depot maintenance facilities and back to the operational units. Examples are special transportation of tracked vehicles to and from training areas and one-time costs of retrograding equipment that is being replaced by the materiel system. Costs must be system specific and clearly identified. It excludes transportation funded by stock fund/AWCF and movement of cargo by TOE units as part of their mission functions.

5.08 SOFTWARE

This element includes all O&M-funded costs for software. This would normally be predominately . However, this element should include any software development, procurement, and support costs that were not funded by either the RDT&E or the procurement appropriations.

5.09 SYSTEM TEST AND EVALUATION, OPERATIONAL

This element includes the O&M-funded costs of system-specific test activities, including costs of specially fabricated hardware, to obtain or validate engineering data on system performance. It also includes costs of the detailed planning, conduct, support, data reduction, and reports from such testing. The actual test articles (i.e., functionally configured systems) are excluded from this element; they should be included in the prototype manufacturing or manufacturing elements.

5.10 SYSTEM ENGINEERING/PROGRAM MANAGEMENT

5.101 PROJECT MANAGEMENT ADMINISTRATION (PM CIV)

This element includes the O&M-funded costs of the PM's office (not funded by the RDT&E, or procurement) for system engineering and technical control, as well as the business management of the system/program. It encompasses the overall planning, direction, and control of the definition, development, and production of the system/program, including functions of logistics engineering and ILS management, e.g., maintenance support, facilities, personnel, training, testing, and activation of a system. Also included are any PM office O&M-funded costs to manage and administer environmental efforts, e.g., PM environmental management team, and compliance with the National Environmental Policy Act (NEPA) and the National Aerospace Standard (NAS) 411 for pollution prevention plans.

5.102 OTHER

This element includes the costs of any other O&M-funded costs for system engineering and technical control, as well as the business management of the system/program. It encompasses the overall planning, direction, and control of the definition, development, and production of the system/program, including functions of logistics engineering and ILS management, e.g., maintenance support, facilities, personnel, training, testing, and activation of a system.

5.11 TRAINING

This element includes the O&M-funded costs of system-specific, individual training for replacement personnel. The training can include a specific course taught in a TRADOC school and/or transition training for qualifying the replacement personnel. It includes recurring costs associated with training materiel and devices. It excludes the MP costs associated with the instructors and students, and the procurement costs for training ammunition/ missiles.

5.12 OTHER O&M

This element includes any O&M-funded costs not included in the previous elements. Costs must be system specific and clearly identified. They may include supplies, direct support operations, indirect support, environmental efforts (pollution prevention, compliance, remediation, and restoration), and quarters, maintenance, and utilities (QMU) that are not included above. In the event that any R&D or production efforts are O&M-funded costs and are not captured above, they should be separately identified under this cost element.

6.0 ARMY WORKING CAPITAL FUND (AWCF) ELEMENT

6.01 AWCF CLASS IX WAR RESERVES

This element includes the costs of Class IX war reserve components, assemblies, and subassemblies determined to be combat critical for maintaining and sustaining combat operations of the materiel system until resupply can be accomplished, which are procured with Supply Maintenance, Army operating cost authority and held to satisfy the War Reserve Materiel Requirements.

APPENDIX F - COST ANALYSIS TECHNIQUES

Section I - Manpower Costing

1. Manpower cost analysis

a. This appendix provides guidance on manpower costing of the materiel system's life cycle. Manpower includes the number of personnel (military officers/enlisted, civilian, and contractor) required to operate, maintain, support, and train for full operational deployment of a materiel system. This section covers manpower cost tools and cost elements. One of the tools used for costing manpower is the Army Manpower Cost System (AMCOS). This system consists of three life cycle cost modules - (1) the Active, (2) the Reserve, and (3) the Civilian modules.

b. Manpower cost analysis is an analytical approach, using cost tools and techniques, to develop personnel costs for the POE, CCA and the ACP estimates for materiel systems and information management systems. Analysis should be based on the MER, if available.

c. The manpower cost elements used in the POE and the CCA are defined in Appendix E. Additional guidance and an explanation of the cost elements is provided in section 1-5, Manpower cost elements, below. The same cost elements and manpower costing tools are used by the CRB to develop the ACP. For questions regarding manpower life cycle costing contact CEAC, Forces, Operations and Installations Cost and Economic Analysis Division, commercial (703) 756-0336, DSN 289-0336.

2. Military manpower costing tools

This section covers military personnel costing tools. There are several tools that can be used to cost military personnel.

a. Manpower Estimate Report (MER) or like documents to identify the number of military personnel assigned to the specific weapon system (identified by grade and Military Occupational Specialty (MOS)).

b. AMCOS. The AMCOS Active module provides manpower life cycle costs by MOS/grade. AMCOS Active module cost elements consist of:

(1) Military Compensation
   (a) Basic Pay
   (b) Allowance for Quarters
   (c) Variable Housing Allowance
   (d) Basic Allowance for Subsistence
(2) Acquisition
(3) Recruiting
(4) Permanent Change of Station
(5) Retired Pay Accrual
(6) Selective Reenlistment Bonus
(7) Other Benefits

(8) Special Pays

(9) Training

(10) Medical Benefits

(11) Morale, Welfare, and Recreation

(12) New GI Bill

c. The Composite Standard Rates (CSR) can be used to cost military manpower. These rates are used for pricing, estimating, budgeting, costing and billing for U.S. Army personnel services provided to other federal agencies, non-DoD customers, and to foreign military sales customers. These rates consist of six cost elements:

(1) Basic Pay

(2) Retired Pay Accrual

(3) Allowance for Quarters

(4) Miscellaneous Expense

(5) Permanent Change of Station

(6) Incentive and Special Pay

d. The AMCOS Reserve module may be required if reserve personnel are assigned to the materiel system.

e. The Automated Cost Estimating Integrated Tools (ACEIT) is an estimating system containing a variety of tools designed to assist cost analyst with cost estimates.

3. Civilian manpower costing tools

This section covers civilian manpower personnel costing. Civilian manpower costing addresses personnel that are required to operate, maintain, support, or train for full operational deployment of a materiel system. The following are used to cost civilian manpower.

a. MER or like documents that identify the number of civilians assigned to the specific materiel system (identified by grade/series).

b. The AMCOS Civilian module is a tool that can be used to cost civilian manpower. The civilian life cycle cost module and data base is used for the POE, CCA, and special manpower studies. AMCOS Civilian module cost elements consist of:

(1) Base Pay

(2) Retirement Benefits

(3) Premium Pay

(4) Other Benefits

4. Dedicated/non-dedicated manpower

a. When manpower is dedicated to a particular materiel system, manpower costing is relatively simple. However, when manpower costing is shared with two or more materiel systems, the manpower costing process is more complex.

b. Definitions:

(1) Dedicated manpower - personnel assigned full-time to a materiel system.

(2) Non-dedicated manpower - personnel assigned part-time to a materiel system.

c. An hourly rate is derived from identifying the annual cost of the personnel divided by the annual man-hours. This hourly rate is then multiplied by the productive man-hours to give the dedicated costs to a particular materiel system.

5. Manpower cost elements

This section provides guidance on the use of AMCOS for costing manpower cost elements as defined in Appendix E.

RESEARCH, DEVELOPMENT, TEST, AND EVALUATION (RDT&E)-FUNDED ELEMENTS

1.051 PROJECT MANAGEMENT ADMINISTRATION (PM CIV/MIL)

a. Use AMCOS Civilian module to compute this element for civilian personnel only.

b. Use AMCOS Active module to compute this element for military personnel **only** when RDT&E funds are used to reimburse the military personnel appropriations.

PROCUREMENT-FUNDED ELEMENTS

2.041 PROJECT MANAGEMENT ADMINISTRATION (PM CIV/MIL)

a. Use AMCOS Civilian module to compute this element for civilian personnel only.

b. Use AMCOS Active module to compute this element for military personnel **only** when Procurement funds are used to reimburse the military personnel appropriations.

2.11 TRAINING AMMUNITION/MISSILES

Use the AMCOS Active module. Input the military manpower requirements by MOS/grade and select cost element 2.11 from the CCA/POE menu selection.

MILITARY PERSONNEL (MP) DIRECT-FUNDED ELEMENT

4.01 CREW

Use the AMCOS Active module. Input the military manpower requirements by MOS/grade and select cost element 4.01 from the CCA/POE menu selection.

4.02 MAINTENANCE (MTOE)

Use the AMCOS Active module. Input the military manpower requirements by MOS/grade and select cost element 4.02 from the CCA/POE menu selection. This element addresses dedicated and non-dedicated personnel (see section 1-4. for additional guidance).

4.03 SYSTEM-SPECIFIC SUPPORT

Use the AMCOS Active module. Input the military manpower requirement by MOS/grade and select cost element 4.03 from the CCA/POE menu selection.

4.041 PROJECT MANAGEMENT ADMINISTRATION (PM MIL)

Use the AMCOS Active module. Input the military manpower requirements by MOS/grade and select cost element 4.041 from the CCA/POE menu selection.

4.042 OTHER

Use the AMCOS Active module. Input the military manpower requirements by MOS/grade and select cost element 4.042 from the CCA/POE menu selection.

4.051 TRAINING

Use the AMCOS Active module. Input the military manpower requirements by MOS/grade and select cost element 4.051 from the CCA/POE menu selection.

4.052 PERMANENT CHANGE OF STATION (PCS)

Use the AMCOS Active module. Input the military manpower requirements by MOS/grade and select cost element 4.052 from the CCA/POE menu selection.

4.06 OTHER MP

Use the AMCOS Active module. Input the military manpower requirements by MOS/grade and select cost element 4.06 from the CCA/POE menu selection. This element is the MPA file applied to military personnel not mention above but clearly identified as specific to the system. An example would be fuel handlers.

OPERATIONS AND MAINTENANCE (O&M)-FUNDED ELEMENTS

5.01 FIELD MAINTENANCE CIVILIAN LABOR

Use AMCOS Civilian module. Input the civilian manpower requirements by grade/series and select cost element 5.01 from the CCA/POE menu selection.

5.061 OVERHAUL (P7M)

Use AMCOS Civilian module. Input the civilian manpower requirements by grade/series and select cost element 5.061 from the CCA/POE menu selection.

5.063 SUPPLY DEPOT SUPPORT

Use AMCOS Civilian module to cost the manpower directly identifiable to end-item supply operations. Input the civilian manpower requirements by grade/series and select cost element 5.063 from the CCA/POE menu selection.

5.101 PROJECT MANAGEMENT ADMINISTRATION (PM CIV)

Use AMCOS Civilian module. Input the civilian manpower requirements by grade/series and select cost element 5.101 from the CCA/POE menu selection.

5.102 OTHER

Use AMCOS Civilian module. Input the civilian manpower requirements by grade/series and select cost element 5.102 from the CCA/POE menu selection.

5.11 TRAINING

Use AMCOS Active module. Input the military manpower requirements by MOS/grade and select cost element 5.11 from the CCA/POE menu selection.

Section II - Guidance For Including Surcharges And Credits In Cost Estimates For Depot Level Reparables And Consumables

1. Purpose

The purpose of this Appendix is to provide background and procedures for estimating the cost of a Depot Level Reparable (DLR) and a Consumable in Program Office Estimates (POE), and Component Cost Estimates (CCA) and other cost estimating products. A Glossary of terms and pertinent definitions is at Annex A.

2. Background

a. Two Defense Management Review Decisions (DMRDs) require the inclusion of surcharges in Army Master Data File (AMDF) prices and the change from procurement funding to operations and maintenance funding for Replenishment Depot Level Reparables (DLRs) under the Supply Management, Army (SMA), formerly Army Stock Fund (ASF). Both changes became effective in FY 92 and fall under the umbrella concept of the Army Working Capital Fund (AWCF). [See Chapter 5.]

b. DMRD 901 "Reducing Supply System Costs" requires that the Army become more efficient in buying, managing, and distributing materiel. In order to become more efficient, a basic two pronged approach was implemented: reduce unit demands to only those things that cannot be fixed, and reduce the total cost of providing unit supplies by improving the efficiency in the delivery of supplies. DMRD 901 directed that all costs for, or directly related to, stock-funded items be included in the price paid by customers; those costs include personnel, transportation, repair, items beyond repair (washouts), storage, and other associated costs.

c. DMRD 904 "Stock Funding of Reparables" transferred Army funding of repairable parts from procurement appropriations to stock funds. It affected the cost element structure and the definition of cost components used in Army resource management, particularly in the management of operating and support costs. Units must fund replacement DLRs out of their operations and maintenance (OMA) account. Therefore, customer operations accounts increased and customers received credit for unserviceable and serviceable returns for which there remained a valid Army requirement to offset part of the cost.

d. Stock funding of DLRs affords the Army the benefit of improved secondary item inventory management and financial management. Instead of having one appropriated fund for procurement and another for repair, the Supply Management, Army (SMA) funds both. The accounting and reporting functions for the ASF is decentralized and performed at the branch office/MSC level. Thus, the customer would become more judicious when placing order for high dollar value items, which would reduce demand, thus freeing up OMA funds for other requirements.

e. Several key policy decisions changed the way cost estimating for DLR (Spares) and Consumables (Repairs) is done. There were changes in terminology, stock fund procedures, and surcharge and credit policy.

(1) Terminology

Beginning in FY 92, all secondary items were realigned into two categories: reparables (a.k.a. DLRs, SFDLRs) and consumables. The terms DLR and consumable are from the wholesaler's perspective, where a DLR is a part which must be returned to the depot (wholesale supply system) for repair. However, many parts can be repaired at the retail level, such as a Direct Support Unit, and still be classified as a reparable. The Army Master Data File (AMDF) contains these data, along with the price, for each item. See Glossary for more detailed description of reparable, consumable, and AMDF.

(2) Stock Fund

Under the Stock Funding of Depot Level Reparables (SFDLR) concept, replenishment DLRs (5.03) are purchased from producers by the SMA portion of the AWCF and sold to the unit. The unit pays for them with OMA dollars. Initial DLRs (2.101) are purchased by the AWCF which is reimbursed by appropriated dollars when issued to the PEOs/PMs (initial issue is reimbursed by procurement authority).

(3) Surcharge

DMRD 901, "Reducing Supply System Costs," directs that all costs for, or directly related to, stock-funded items be included in the price paid by customers. A surcharge is included in the price of the consumables and reparables (DLRs) to cover personnel, transportation, repair, storage, and associated costs. Beginning in FY 92, the published AMDF prices included the applicable surcharge. Army units are funded based on AMDF prices, therefore they are funded for the surcharge. Surcharges are developed on a periodic basis by Army ODCSLOG and approved by the Office of the DoD Comptroller.

(4) Credit

A credit, or percentage of the item price, is given to the customer for each DLR turned in to the supply system. DA, ODCSLOG provided Major Subordinate Command (MSC)-specific credit rates for DLRs. These are composite rates derived from rebuild cost and washout rates. Army units are funded using these rates. However, credit rates for consumables are not applicable to costing because any turn-in of a consumable is usually the result of an ordering adjustment and thus is not tied to usage of the equipment.

3. Procedures

a. Cost estimating for Consumables and DLRs involve three steps: establishing item price, making adjustments to the price (i.e. surcharges and credits), and developing operating costs for the item. The following methodology assumes that an AMDF price is available. See paragraph 2-3.d. below when AMDF prices are not available.

b. The application of surcharges and credits affects the cost estimate of initial DLR, initial consumables, replenishment DLR, replenishment consumables, and war reserves. Below are the corresponding cost elements shown in Appendix E of this manual along with a description of how to do the cost estimate for each. For the formulas below:

MSC = MSC specific credit rate

Q = Quantity

P = AMDF or AMDF-equivalent price

(1) Initial DLR (Procurement 2.101)

DLRs are costed using the most recently published AMDF price (standard price), which includes a surcharge, and is adjusted for inflation. If the DLR is a new item, the manufacturer's production price is used. Credits should not be considered when costing initial DLRs since they are purchased by the Program Manager and issued free with the end item. When the initial DLR becomes unserviceable, the credit for its turn-in will be applied to the replenishment DLR. Initial DLRs should be costed using Procurement Appropriation funding in the year of fielding.

(2) Initial Consumable (Procurement 2.102)

Consumables are costed using the most recently published AMDF price (standard price), which includes a surcharge, and is adjusted for inflation. If the consumable is a new item, the manufacturer's production price is used. Credits should not be considered when costing initial consumables since they are purchased by the Program Manager and issued free with the end item. Initial consumables should be costed using Procurement Appropriation funding in the year of fielding.

(3) Replenishment DLR (OMA 5.03)

(a) DLRs are costed using the most recently published AMDF price (standard price), which includes a surcharge, and is adjusted for inflation. Credits must be considered, since the assumption is that there will be turn-ins of unserviceable DLRs. The MSC-specific credit rate is a percentage specific to each fiscal year.

(b) The equation for costing a specific item is:

$$\text{Cost} = (1 - [\text{MSC}/100]) \times P$$

This approximates the item's net cost from the Army wholesaler. Replenishment DLRs should be costed using OMA funding in the year of operation. Therefore, it is important to determine the first year of "replenishment" after the fielding of a new system.

(c) The ODCSLOG Return Rate must also be considered when estimating Replenishment DLRs, this changes periodically. The assumed ODCSLOG Return Rate goal is for 95% of all DLRs to return to the system. The 5% of DLRs that do not make it back to the system must be fully costed (5% of projected total demand times the AMDF price) since the commodity manager will have to purchase replacements from the manufacturer. The remaining 95% of the projected total demand should be costed using the MSC-specific credit rate. The equation for costing the total demand is:

$$\text{Cost} = (.05 \times Q \times P) + (.95 \times Q \times P[1 - (\text{MSC}/100)])$$

(4) Replenishment Consumable (OMA 5.04)

Consumables are costed using the most recently published AMDF price (standard price), which includes a surcharge, and is adjusted for inflation. Credits need not be considered for costing purposes since the assumption is made that there will be no turn-in of consumables; units will consume what they order. Replenishment

Consumables should be costed using OMA funding in the year of operation. Therefore, it is important to determine the first year of "replenishment" after the fielding of a new system.

(5) War Reserves (AWCF 6.01)

War Reserves are costed using the most recently published AMDF price, which includes a surcharge and is adjusted for inflation. Credits need not be considered, since the assumption is no turn-in of war reserves. War Reserves should be costed using AWCF Budget Authority.

c. Operating costs are usually expressed in terms of dollars per hour or per mile basis multiplied by the system density. Established cost factors may be used as a starting point to estimate operating costs. Operating costs must be spread over the useful life of the system.

d. When AMDF prices are not available, an AMDF-equivalent price must be developed.

(1) This can be done by using a Cost Estimating Relationship (CER) to estimate the AMDF-equivalent price. Use of a CER requires review of the relevant historical data. Valid relationships between cost and definable physical attributes or operational characteristics must be set up in order to establish a base price.

(2) Adjustment(s) for the inclusion and exclusion of surcharges and credits must then be made. If acquisition costs (cost to acquire item from the manufacturer) are used, the appropriate base surcharge must be added regardless of whether the item is a consumable or reparable (DLR).

(3) If the item is a DLR, a distinction must be made between initial and replenishment DLRs. Only replenishment DLRs need to be adjusted using the MSC-specific credit rates, as described in paragraph 2-3.a. above. Therefore, it is important to determine the first year of "replenishment" after the fielding of a new system.

(4) As a final step, the proper inflation factors must always be applied to develop the AMDF equivalent price. New inflation guidance is distributed annually from OSD.

4. AWCF Operations

a. The Army frequently competes for replenishment DLRs and consumables rather than purchasing them directly from the original manufacturer. However, this depends on availability and cost of the item(s). The development contractor should provide the PMO a list of items that should be stocked, and indicate whether they are critical or not. The PMO and the designated Logistics Support Activity (LSA) would then determine the details of the provisioning process, including retail level requirements, referred to as the Authorized Stockage List and Prescribed Load List (ASL/PLL), and the wholesale level requirements designated for the Depots. The PMO and the LSA would then work with the AWCF to develop a contracting strategy so that the appropriate quantity is available at the retail and wholesale level in a timely manner. The AWCF has contracting authority.

b. The wholesale pipeline funding is the responsibility of the AWCF, specifically, the Supply Management, Army (SMA) business area. The AWCF receives appropriated funds from Congress to buy and sell secondary items (consumables and reparables) to the retail level or unit level. Therefore, the investment cost of the pipeline is born by the AWCF, but is recouped at the end of the life cycle when it sells off the remainder of the pipeline and doesn't replace it.

c. While the system is in the field, AWCF Obligational Authority (OA) is increased in order to buy all the replenishment DLRs and consumables. The AWCF is then reimbursed by OMA dollars from units that are purchasing the parts.

d. There are a few items that cannot be handled by the process described above. These items are either so expensive or so unique that it is not cost effective for AWCF to buy these and stock them.

5. System Cost Estimating

a. The PM is responsible for estimating the quantity and cost of all secondary items (consumables and reparables) associated with the system being fielded. This includes both the wholesale (depot) and retail (MSC item manager and unit) levels.

b. Procurement dollars are used to fund initial spares (now referred to as DLRs) and initial repairs (now referred to as consumables). OMA dollars are used to fund replenishment reparables and consumables.

c. The revolving part of AWCF, or the cost of the pipeline, does not go into the POE/CCA. That is, an estimate of AWCF obligational authority is not included because it is transparent to the unit, or customer. However, the OMA appropriations should reflect the funds that the units will need to reimburse the AWCF for the necessary quantity of replenishment parts at a given price over the life of the system.

d. The cost estimate, and PM procurement funding, for initial consumables and reparables should be the same. The quantity should be based on ASL/PLL requirements, in order to accurately complete initial fielding. For replenishment consumables and reparables, the cost estimate, and unit OMA funding, should be based on annual procurement requirements, or unit consumption rates. The cost estimate must consider the requirement for common components vs. system peculiar or unique components. In either case, consideration must be given to the "spares to availability" criteria by accounting for the Mean-Time-Between-Failure (MTBF) and other appropriate demand rate indicators affecting procurement requirements. Depot availability should not be an issue. What AWCF does to meet the procurement requirements is immaterial to the unit. The unit will still have to have OMA funds to buy the item whether it is currently stocked at the depot or not.

Annex A - Glossary/Definitions

Army Master Data File (AMDF)
An automated data system maintained by the Army Materiel Command (AMC) used to record supply management information for the Army. It contains many different fields and codes to describe an item (e.g. unit weight and price, units of measure and issue, supply class and repair codes). A combination of these codes determines the separation of Class IX into consumable and reparable categories. The Maintenance Repair Code (MRC) and the Automatic Return Item (ARI) code together indicate whether a part is to be repaired when unserviceable, instructions for component return and the lowest level of maintenance authorized to perform the repair (e.g. wholesale level, Depot; or retail level, Direct Support Unit). The Materiel Category (MATCAT) code is used to identify which MSC manages the part. (See Consumable and Reparable definitions for code combinations.)

AMDF Price
The AMDF contains the most recently approved price for an item in the inventory with a unique NSN. The AMDF price will show the latest known representative procurement cost plus authorized surcharges. The AMDF price is set once a year by the Item Manager at the appropriate MSC. AMDF prices are then approved by OSD and HQDA and fixed for each fiscal year. The only way a price can change during the year is if there is a greater than 20% change in price of an item as documented by a recent procurement. A thorough investigation is then conducted before the price change is entered in the AMDF. AMDF prices are expressed in the current fiscal year dollars.

Army Stock Fund (ASF)
A revolving capital fund designed to finance the supply pipelines between the user and the vendor.

It is now called Supply Management, Army (SMA) and it is part of the Defense Business Operating Fund (AWCF). The SMA will finance the peacetime operating stock requirements for both consumable and reparable secondary items. It will also fund the wholesale (depot level) and retail (general support level) maintenance requirements for AWCF owned reparable items.

Army Working Capital Fund (AWCF)
Revolving Fund established under DMRD 971 in FY 92 with the goal of balancing total revenues with total net operating costs. All existing industrial and stock funded activities were encompassed in AWCF, which operates like a commercial business. It purchases supplies from vendors with stock funds and sells those supplies to customers, and then uses the proceeds from those sales to buy more supplies and pay operating costs.

AWCF Business Area
An activity financed under AWCF. Criteria for inclusion in the AWCF as a Business Area are: outputs can be identified, costs can be related to outputs, and customers can be identified. There are currently three Army business areas in AWCF, including Supply Management which covers secondary items.

Class IX Supply Category
This category identifies items which are repair parts. This includes kits, assemblies, and subassemblies, used in the repair of end items. It includes any item, reparable or nonreparable, which is needed to provide maintenance support to any equipment.

Consumable
Defined by AMDF field attributes. Specifically, consumables are those parts with MRC = 'F', 'H', or 'O' and an ARI not equal to 'C', 'E', 'R', 'S', or MRC equal to 'Z', 'B', 'G', '-' and Blank. (By default, they are parts that are not reparables/DLRs.) Generally, any part, assembly, subassembly or component consumed in the operation, maintenance, and support of a primary system and associated support equipment at the unit level. Typically, a consumable is consumed in use and has no salvage or rebuild value. Excludes critical items stocked at General Support, Direct Support or Unit level.

Credit
Percentage of the standard price (AMDF price) refunded to the customer for the turn-in of unserviceable reparable items to the depot system for repair. For reparables, it is developed using rebuild cost and washout rates. The reparable credits vary among the different Commodity Commands of the Army Materiel Command.

Depot Level Reparables
Defined by AMDF attributes. Reparables are defined as secondary items with a MRC = 'D', 'L', or field level reparable items with MRC = 'F', 'H', or 'O', and an ARI code of 'C', 'E', 'R', or 'S'. Generally, any part, assembly, subassembly or component required on a recurring basis for the repair of major end items of equipment subsequent to fielding. A DLR is a secondary item reparable that can be completely repaired only at the depot level or special repair activity (SRA). Includes critical items at General Support, Direct Support or Unit Level. Typically, DLRs are returned to the supply system for repair/rebuild when broken.

Depot Maintenance
Maintenance of secondary items that support the supply system at the wholesale level. Maintenance capability at depots includes overhaul; modification; calibration; analytical, special, and nondestructive testing and inspection; cannibalization; and fabrication of assets. Typical activities are rebuild of vehicles/aircraft and the rebuild of a DLR.

Rebuild Cost
The cost required to restore an item to its previous normal operating condition.

Return Rate
The rate at which reparable secondary items are sent back to the depot for repair.

Reparable
Defined by AMDF attributes. Any part, assembly, subassembly or component required for installation in the maintenance or repair of an end item, subassembly or component, subsequent to fielding, at a depot or special repair activity (SRA). Includes critical items at general support, direct support or unit level maintenance levels.

Revolving Fund
A working capital fund whose basic structure serves two purposes: first, to capitalize the costs of producing goods or providing services, and second, to buy and hold inventories until the customer or user pays for them. Market demand sets the level of operation. However, over the long run, revolving funds must break even. This causes prices, as well as the corresponding surcharges, to fluctuate from year to year.

Secondary Item
A reparable or consumable item under the SFDLR Plan that is included in the stock fund account. Secondary items are centrally managed by Army Inventory Control Points (ICP).

Stock Funded Depot Level Reparable (SFDLR)
Another term for Depot Level Reparable (DLR). (See definition above.)

Supply Management, Army (SMA)
A AWCF business activity (formerly Army Stock Fund) that sells secondary items (consumables and reparables).

Surcharge
Percentage included in the formula prescribed for computing the standard price for an item to cover estimated transportation costs, inventory maintenance, foreseeable net losses, price stabilization, and other expenses relating to such items, as authorized.

Unit Level Maintenance
Unit maintenance is performed at the battalion level and by mobile teams operating from the battalion level that support operational units. Unit level maintenance operations normally include preventive maintenance checks and service inspections, lubrication, cleaning, preserving, tightening, replacing, minor adjustments, diagnosing, fault isolating, replacing unserviceable consumable parts authorized by the Source, Maintenance, and Recoverability (SMR) code, and verifying faults and levels of repair.

War Reserve
Stocks that are routinely maintained at levels necessary to support wartime operations. War Reserve stocks will be funded through a separate congressional appropriation to AWCF.

Washout Rate

The engineering estimate based on historical data of the percentage of parts that, after failure, will be determined to be beyond economical repair.

Wholesale Pipeline

The processing and moving of both serviceable and unserviceable secondary items (DLR) through the supply system. This includes transportation and transaction costs, as well as the cost of the item. Since these costs are reflected in the surcharge to the standard AMDF price, it is no longer necessary to separately cost the wholesale pipeline in weapon system cost estimates. The wholesale pipeline for both DLRs and consumables for a weapon system is initially purchased by the SMA business area of AWCF. It is no longer purchased with appropriated dollars. During the life of the system, the SMA sells parts to units, repairs DLRs and buys new parts from suppliers, always maintaining a "pipeline" of parts in stock or on order. At the end of system life, that pipeline will be sold and not replaced. Since customers now purchase DLRs until disposal of the system, replenishment DLR costs should be shown for all years since the cost of doing business (i.e. maintaining the wholesale pipeline) is funded by the surcharge to the standard price.

APPENDIX G - FORCE COST MODEL ELEMENT STRUCTURE AND DEFINITIONS

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Section II - Force Cost Element Definitions

1.0 ACQUISITION OF RESOURCES (1.1 + 1.2)

Procurement of resources within, or with an increase in, end strength. If end strength is not increased then there are no personnel (1.2) costs.

1.1 Material acquisition (1.1.1 through 1.1.9)

All authorized equipment, initial issue ammunition, clothing, field equipment, replenishment spares and repair parts and technical manuals/publications.

1.1.1 Equipment (1.1.1.1 through 1.1.1.6)

Cost of aircraft, missiles, weapons & tracked vehicles; other procurement including tactical & nontactical vehicles, telecommunications and other support equipment; ammunition items and special weapons; and, O&M major end items.

1.1.2 Ammunition Initial Issue

The cost of the basic quantity of ammunition for the organization. Allocated based on the number of personnel assigned, the type and quantity of equipment and type of unit.

1.1.3 Organizational Clothing & Individual Equipment

Cost includes all authorized individual clothing and equipment. The cost is dependent upon variables such as type of unit, climatic zone, and authorized level of organization (ALO).

1.1.4 Consolidated Table of Allowances (CTA) Field Equipment and Medical Items.

The cost for items allocated based on the number of personnel, the type and equipment, and/or the type and size (CO, BN, BDE, etc.) of the unit.

1.1.5 PLL/ASL

1.1.5.1 PLL - Prescribed Load List

The basic load of repair parts the unit keeps on hand.

1.1.5.2 ASL - Authorized Stockage List

The basic load of repair parts the Direct Support Unit (DSU) maintains for the unit.

1.1.6 Class 1,2,3 Basic Load

The basic load of field rations, clothing and packaged POL the unit keeps on hand.

1.1.7 Replenishment Spares (Wholesale)

Spare components, assemblies and subassemblies (reparable items) to support end items of equipment to sustain the spares supply pipeline.

1.1.8 Replenishment Repair Parts (Wholesale)

Individual parts, assemblies, or subassemblies (nonreparable) required to support end-items of equipment to sustain the repair parts supply pipeline.

1.1.9 Publications

Technical publications, e.g., how to operate, maintain, or repair, associated with each line item number piece of equipment.

1.2 Personnel Acquisition (1.2.1 through 1.2.4)

Cost of procurement of military personnel for the SRC unit.

1.2.1 Recruiting

The cost, by appropriation, to recruit each authorized member of the unit.

1.2.1.1 Military Pay Funded (MPA)

Military salary costs.

1.2.1.2 O&M Funded (OMA)

Acquisition/recruiting costs.

1.2.2 Training through initial MOS

Cost, by appropriation, is keyed to E-3 pay rate and cost of formal initial MOS training for the MOS.

1.2.2.1 Military Pay Funded (MPA)

1.2.2.2 O&M Funded (OMA)

1.2.2.3 Other Funded (AMMO)

1.2.3 Clothing Initial Issue

Contains a list and cost of authorized initial clothing items for respective male and female enlisted members. Often called or referred to as clothing bag.

1.2.4 Accession Travel

Cost of enlisted accession travel from home to point of entry for training or duty.

2.0 ACTIVATION (2.1 + 2.2)

Costs to move all of the unit equipment and personnel from the location at which the unit was formed to its permanent home station.

2.1 Transportation (2.1.1 + 2.1.2)

2.1.1 Material

Transport of unit equipment to a permanent home station.

2.1.2 Personnel-PCS Travel for Military

Transport of personnel to a permanent home station.

2.2 Military Construction

2.2.1 Facilities

Construction of installation buildings and utilities for use by the unit/organization.

2.2.2 Army Family Housing

Construction of housing for married personnel in the unit.

3.0 OPERATIONS (3.1 through 3.4)

Annual direct and indirect costs to operate the force unit selected at the specified ALO, Training Readiness Rating, MACOM, and Component. The estimate includes the cost of Direct Equipment Parts and Fuel Costs, Indirect Support Costs and Other Unit Support.

3.1 Direct Equipment Parts and Fuel Costs (3.1.1 through 3.1.2)

3.1.1 Training Operations

Includes cost of air and ground operations, replenishment spares and repair parts, non-OSMIS equipment operating costs and POL. Costs are calculated with annual operational tempo and OSMIS factors. OSMIS factors are expressed as the cost per unit of OPTEMPO. A non-OSMIS equipment operating cost is computed by applying scaling factors (ranging from 3% to 9%) to the ground operations cost estimate.

3.1.2 Training Ammunition & Missiles

Costs are based on the average ammunition expenditures of like units over the last four years.

3.2 Indirect Support Costs (3.2.1 through 3.2.10)

Costs are calculated with MACOM per capita cost factors and SRC personnel populations.

3.2.1 Transportation to Training Sites

3.2.2 Supplies and Equipment

3.2.3 Contractual Services - Field

3.2.4 Mission Travel

3.2.5 Equipment Leases

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3.2.7 Purchased Equipment

3.2.8 Admin Travel

3.2.9 Civilian Labor

3.2.10 Other

3.3 Personnel (3.4.1 + 3.4.2 + 3.4.3)

Costs include training replacement personnel through initial MOS, initial (enlisted) clothing issue and PCS travel for military and dependents.

3.3.1 Replacement Personnel (3.4.1.1 + 3.4.1.2)

The costs are based on MACOM enlisted rotation rates, expressed as a percentage of assigned personnel, to determine the cost of training through initial MOS for replacement personnel. Rotation rate is synonymous to attrition rate.

3.3.1.1 Training through initial MOS

Costs include military pay funded (MPA), O&M funded (OMA) and OTHER funded (AMMO).

3.3.1.2 Clothing Initial Issue

The costs are based on MACOM enlisted rotation rates, expressed as a percentage of assigned personnel, to estimate clothing costs for replacement personnel/annual operations.

3.3.2 PCS Travel for Military & Dependents

The cost calculation includes applying of officer/warrant officer and enlisted rotational PCS cost factors and, in turn, respective MACOM officer/warrant officer and enlisted rotation rates.

3.3.3 Military Personnel (3.4.3.1 + 3.4.3.2)

3.3.3.1 Basic Pay and Allowances

Includes base pay, BAQ, BAS, retired pay accrual, FICA, station allowance, survivor benefits, enlisted clothing allowance, enlisted reenlistment and separation allowances.

3.3.3.2 Special/Incentive/Hazardous Duty Pay

Cost incentive pay authorized for performance of hazardous related duties, e.g., flight or parachute jump, or special skills such as physician's duties.

3.4 Other Unit Support (3.5.1 through 3.5.6)

3.4.1 BASOPS (-) (Base Operations) & RPMA (Real Property Maintenance)

Repair and maintenance of facilities: Buildings/structures, utilities, roads and grounds.

3.4.2 Medical Support below General Hospitals

Medical clinics and other medical service activities.

3.4.3 Army Family Housing Operations & Maintenance

Property operations and maintenance oriented for/to Army family housing.

3.4.4 Army Family Housing Leases

Cost for housing leased in the private sector for military personnel.

4.0 MOVEMENT (4.1 + 4.2)

Costs to move an entire unit either on a tactical deployment or an administrative relocation.

4.1 Materiel (Tactical/Administrative) (4.1.1 through 4.1.6)

Costs are calculated for movement of unit equipment and materiel from a specified MACOM/Installation location or point of origin to a specified MACOM/Installation destination, using one or more modes of transportation.

4.1.1 Aircraft Self Movement

4.1.2 Wheeled Vehicle Self Movement

4.1.3 Rail movement of equipment/materiel

4.1.4 Truck movement of equipment/materiel

4.1.5 Air movement of equipment/materiel

4.1.6 Sea movement of equipment/materiel

4.2 Personnel (4.2.2 through 4.2.4)

4.2.1 Administrative

Costs (PCS) for movement of all unit personnel, personnel dependents, and household belongings.

4.2.2 Tactical (Air) (w/o dependents)

Tactical transport of unit personnel by air.

4.2.3 Tactical (Bus) (w/o dependents)

Tactical transport of unit personnel by bus.

4.2.4 Tactical (Rail) (w/o dependents)

Tactical transport unit personnel by rail.

5.0 INACTIVATION (5.1 + 5.2)

A unit can cease to exist due to a variety of reasons. Whenever a unit is inactivated there are savings and costs associated with the scenario. Operations and maintenance savings are generated by an inactivation (ceasing operations). Costs, in the form of redistribution of personnel and equipment, results from the occurrence of an inactivation. And, long-term savings may be offset by short-term cost(s).

5.1 Savings (5.1.1 through 5.1.7)

Annual operations (savings)

5.1.1 Direct Equipment Parts and Fuel Costs

See Annual Operations module: Cost Elements 3.1.1, 3.1.2, 3.2.

5.1.1.1 Training Operations

5.1.1.2 Training Ammunition & Missiles

5.1.2 Indirect Support Cost

5.1.3 Other Training Support

5.1.4 Personnel

Significant savings result only if the Army end strength is reduced by an inactivation. Minimal savings or costs can result with a difference between the SRC pay and allowances in the origin MACOM and SRC pay and allowances in the destination MACOM.

5.1.5 Other Unit Support: O&M
5.1.6 Other Unit Support: AFHO

See Annual Operations module: Cost Elements 3.5.1, 3.5.2, 3.5.3, 3.5.4, and 3.5.5.

5.1.7 Analyst Input

The analyst can input any other savings that are not/were not computed above.

5.2 Costs (5.2.1 through 5.2.5)

5.2.1 Accelerated PCS

The costs for the officer and enlisted various pay and allowances plus applying of respective officer/warrant officer and enlisted PCS rotational factors and, in turn, accelerated PCS rates.

5.2.2 Transfer Standards Maintenance

5.2.3 Equipment Transport

See Movement module, cost element 4.1.

5.2.4 Change (5.2.4.1 + 5.2.4.2)

Analyst entry, or input, costs that are not computed above.

5.2.4.1 O&M Funded (Analyst Input) (OMA funded)

5.2.4.2 AMMO Funded (Analyst Input) (AMMO funded)

5.2.5 Analyst Input

Analyst can input source of funding value not specified and for costs not computed above.

6.0 MODIFICATION

This activity involves modifying the initial unit personnel strength, equipment type/density or OPTEMPO values for a 1.0 - Acquisition of Resources or 3.0 - Annual Operations cost scenario as described below. This enables alignment of a SRC more closely with a particular Modified Table of Organization and Equipment (MTOE) unit (or SRC), or examination of the cost deltas for input personnel strength changes and/or equipment additions or deletions and OPTEMPO changes. Modification of 1.0 - Acquisition of Resources or 3.0 - Annual Operations defaults to the respective force cost element structures for 1.0 and 3.0 because modification doesn't possess a force cost element structure of its own.

Personnel

An initial unit by-grade distribution of personnel is modified with a proposed or required number of personnel changes, in any or all grades, and recosted.

Cost Driver Data

Equipment unit cost, density values and appropriation identity, corresponding to a given LIN and LIN nomenclature, are required to conduct an initial cost estimate and modify an initial cost estimate. The analyst changes the quantity and type of equipment assigned and total cost, for a SRC unit, by modifying any one or all of the aforementioned Cost Driver Data information or data values, except appropriation.

Replenishment (Operational) Driver Data

Equipment LIN, LIN nomenclature, density, appropriation identity; annual mileage or hourly OPTEMPO; and, reparable, consumable, and POL operation and maintenance factor values are needed to conduct an initial and modified acquisition of resources cost estimate. The analyst changes the quantity and type of equipment assigned and operational cost by providing changes to any one or all of the aforementioned Replenishment (Operational) Driver Data information or data values, except appropriation.

APPENDIX H - STUDY PLAN

Developing a study plan is the first step in preparing a cost estimate or conducting an economic analysis. The plan is required and should be submitted to the Director, CEAC, one week prior to a methodology in-process review (IPR). The Director, CEAC, approves the plan at the IPR, and it should be updated as major methodologies change.

Study Plan

Program Name _____
Date _____

1. REFERENCES:

   List all references such as taskings, memorandums, letters, meeting notes, and telephone conversations.

2. MISSION:

   Describe the mission of the system being costed.

3. BACKGROUND:

   Provide background information on how the program evolved to its current stage and the current status of the system (milestone).
   Provide the current funding profile (e.g., FYDP, POM) of the program and the last Army Cost Position (if one exists).

4. PURPOSE OF THE STUDY:

   State the purpose of the study, e.g., OSD-CAIG, ASARC, MAISARC, EA.

5. STUDY SPONSOR AND ANALYST:

   Sponsor: _____ Analyst (name and phone #): _____

6. TASKS:

   Describe what tasks need to be accomplished, e.g., POE, CCA, ACP, EA, special study, sensitivity analysis.

7. ASSUMPTIONS, GROUND RULES AND CONSTRAINTS:

   Provide all assumptions, ground rules and constraints. Give a definition for each not to exceed three or four sentences.

8. WORK BREAKDOWN STRUCTURE (WBS):

Provide a copy of the system WBS and definitions for what is included within each WBS.

9. SYSTEM DESCRIPTION AND CONFIGURATION:

Provide a hardware and software system configuration and definitions.

10. ACQUISITION AND FIELDING SCHEDULE:

Provide an approved current program acquisition and fielding schedule. Also, include a description of the program's acquisition strategy.

11. METHODOLOGY AND DATA:

Provide data and methodology on cost drivers for each WBS. A more detailed discussion of the methodology will be presented at a methodology IPR. This section will be updated to reflect the results of the methodology IPR and data and/or methodology changes during the course of study. This section should also describe any estimating model planned to be used.

12. PROGRAM MILESTONE SCHEDULE:

This section should include the program acquisition schedule based on past, current, and future events.

Event	Date
_____	_____
_____	_____
_____	_____

13. POE/EA, CCA and ACP SCHEDULE OF EVENTS:

Event	Start	Finish
Tasking Letter		
Study Plan		
POE/EA Methodology IPR		
Validated POE/EA to CEAC		
CCA		
Brief CCA to Director, CEAC		
CRB Working Group Meeting		
Brief POE/EA, CCA, and Cost Variance Analysis to CRB		
ACP Approval by the ASA(FM&C)		

14. PROGRAM POINTS OF CONTACT (POCs):

Agency	Name	Phone #
PEO		
PMO		
SARDA		
DISC4		
DCSLOG		
DCSOPS		
Army Budget		
Army PA&E		
OSD-CAIG		
AMC-EM		
MACOM Validator		

15. ISSUES:

Discuss the issues raised in the last CAIG report. List all management, cost, and technical program issues. Provide an explanation for each issue.

APPENDIX I - COST ANALYSIS REQUIREMENTS DESCRIPTION (CARD)

DoD 5000.2-R specifies that the DoD Component sponsoring an acquisition program establish, as a basis for cost estimating, a description of the salient features of the program and of the system being acquired. This information is to be presented in the CARD. DoD 5000.4-M, Chapter 1, provides specific guidance for preparing and updating a CARD.

The CARD is intended to be comprehensive enough to facilitate identification of any area or issue that could have a significant cost impact and, therefore, must be addressed by the cost analyst. It is also intended to be flexible enough to accommodate the use of various estimation methodologies. However, the information provided in the CARD should be limited to the data necessary to support the cost estimation process. In some CARD sections, it may be possible to convey the information pertinent to cost estimation in a few sentences or in a single matrix or table. The input options available to the CARD preparers are identified below. The option exercised should be consistent with the condition of the data.

Input Options Available to CARD Preparers

Condition of Data	CARD Input
1. The required data are available.	Provide the data in the appropriate section of the CARD.
2. The data are contained in another document.	Summarize the data pertinent to cost in the appropriate section of the CARD and provide reference to the more detailed source.
3. There are no significant cost implications associated with that CARD section.	The CARD section should be identified as not relevant (N/R).
4. Sufficiently detailed definition is not yet available.	The available data should be provided and the remainder of the information should be identified as to be determined (TBD).
5. Uncertainty is associated with this area.	A range of values can be specified as opposed to a discrete value. If a range is used, it should be associated with a base case. Include rational for the range as well as a discussion of the significance of its variation for other parts of the system. If possible, designate a most likely or design value.

As a program evolves and matures, it is anticipated that additional data, which will resolve TBDs and uncertainties, will become available and will be incorporated into the CARD.

APPENDIX J - ARMY COST ESTIMATING TOOLS

Section I - Automated Cost Estimating Integrated Tools (ACEIT)

ACEIT is the new standard Army automated framework/spreadsheet designed to increase the productivity of cost analysis work. ACEIT automates the detailed, tedious costing functions allowing the analyst more time to concentrate on the methodology and perform analysis; provides automated assistance in developing documentation of the estimate; and supplies the latest inflation indices for all services and other government agencies (e.g., each year updated inflation indices are distributed throughout the Army via each ACEIT's local point of contact).

ACEIT originated at the Air Force Electronic Systems Division (ESD) and for several years was used by the Air Force in the DEC VAX environment. In 1992, ESD announced and released a personal computer (PC) version of ACEIT. The PC version of ACEIT had much of the required functionality and many of the features desired for Army costing (i.e., a system that would possess a cost estimating relationship (CER) development module, an external data base/model linkage, a CER library linkage and an automatic base year normalization capability). Also, ACEIT has a very strong parametric capability, requiring few enhancements, that can support a strong bottom-up estimating style. Inputting an estimate in ACEIT, the PEO/PM business manager is able to more efficiently use the data to manage programs, prepare budgets and other documents.

The initial Army fielding of ACEIT was in January 1993. Version 2.2, fielded in September 1994, allowed linkage of cost estimates in ACEIT to produce selected P-Forms. Enhancements are continuously being developed and added each year in order for ACEIT to remain a dynamic system for cost analysis. Whenever unresolved errors are found, a Software Error Report Form (SERF) should be completed and forwarded to USACEAC (SFFM-CA-CR). The collected SERFs are reviewed and analyzed using a systematic process to fix the various problems (e.g., bug fixes have the highest priority and nice to have items are worked on last). SERF response time is related to the amount of resources available each year.

The ACEIT system includes:

- Cost Estimating Module - ACE
- Methodology Knowledge Base
- Automated Cost Data Base - ACDB
- Reference Libraries
- Cost Analysis Statistics Package - CO$TAT

CO$TAT is a built in cost analysis statistical package specifically for cost estimators. CO$TAT in addition to providing the link between ACE and the other modules can easily perform statistical analyses commonly used in cost estimation (e.g., basic statistical analysis, linear, log-linear/ non-linear regression, and fit learning and rate curves). CO$TAT also provides data editing and graphical outputs such as scatter plots and histogram review. This module will allow easy linkage to other commercial software products.

New capability is also available with a RI$K computation module and the soon to be completed initial Army Manpower Cost System (AMCOS) link.

Section II - Automated Cost Data Base (ACDB)

The Army is migrating from the USACEAC Information Architecture (INFOARCH) to the PC Automated Cost Data Base (PC-ACDB). The Army and the Air Force joined together with the assistance of some OSD Corporate Information Management (CIM) funding assistance, to develop a common standard data base capability. A complete feature by feature capability analysis was conducted between INFOARCH and the ACDB ported to the PC version with some improvements and the decision was clear that the new PC-ACDB would provide superior capability, be compatible with ACEIT, OSD DoD 5000 series guidance as well as MIL STD 881B.

ACDB provides both the capability to store and recall data submitted to the government in an electronic image of the Contractor Cost Data Reporting (CCDR) or Cost Performance Report (CPR); and, the capability to search and retrieve mapped and normalized cost information. Also, as defined, developed and constructed by the data base administrator, ACDB allows for search and retrieval using technical, schedule and programmatic information. Searches can be simple or complex depending on the requirements, and only possible if the data has been collected and entered into the data base. The retrieved cost and technical data can be loaded into the CO$TAT module for immediate analysis and returned to ACEIT at the desired cost cell along with the resulting statistics. Documentation of the estimate can be produced "on the fly" and the source is clearly indicated. The built in documentation is a large improvement in the "state-of-the-art", but nothing replaces the estimator's description of the analysis process. It is also important for the analyst to describe why a CER was selected, why a data point was not used or why the analogy was used or rejected. Additionally, it is extremely meaningful to describe the multiple alternative approaches for estimating major items and the process of elimination of the less robust approaches. Remember, the listing of the statistics is useful, but not nearly as descriptive as the analytical thought process used to develop the final result.

In the near term, the following converted data bases are planned to be fielded to Army cost organizations:

- Rotary Wing Aircraft
- Missiles
- Weapons and Tracked Combat Vehicles (WTCV)
- Comm-Electronics

And the following five Air Force developed data bases will soon be available:

- Electronics - ESC
- Tactical Missiles - ASC/Eglin
- Peacekeeper ICBM - BMDO
- Human Systems - Human Systems Command
- ECM Systems - ASC/WPAFB

All of theses databases will operate as stand alone or linked with ACEIT. USACEAC encourages maximum participation and feedback from subcommands and all users to strengthen and increase the utility of the databases. Other databases are planned or are already under development.

APPENDIX K - COST RISK ANALYSIS

1. Introduction

Cost risk is very important in determining the potential cost of a program. This Appendix is divided into eight sections. Section 2 provides general background information and a discussion of the some common definitions. Section 3 reviews some basic definitions of risk and uncertainty. Section 4 provides the cost analyst with an overview of the program manager's (PM's) responsibilities to identify, plan for, and manage the risks in their program. Since considerable cost risk can be abated by the PM's management of risk, the information in Section 4 can be useful knowledge for the analyst who must assess and estimate cost risk. Section 5 provides a summation of some of the sources of risk and what is included in each of the three main areas of risk (performance or technical, schedule and cost estimating risk). Section 6 identifies some methods currently being used by analysts to estimate cost risk. Section 7 discusses some of the models available to cost analysts who must include cost risk in their estimates. The main purpose of sections 6 and 7 is to show some of the approaches that have been implemented by field practitioners. Section 8 concludes with some common sense guides for identifying and quantifying the risk in a program.

2. Background

a. Current DoD policy regarding risk is contained in the DoD 5000 documents dated March 15, 1996.

(1) DoD Directive 5000.1 defines the concepts, identifies key officials and forums, and establishes guiding principles for risk assessment and management.

(2) DoD Regulation 5000.2-R, Part 3, Program Structure issues the fundamental guidance that requires PMs to address risk management in their acquisition strategy.

(3) DoD Regulation 5000.2-R, Part 5, Program Assessments and Decision Reviews requires that information produced and distributed to decision-makers include all appropriate information needed by the decision-maker and must include any risks of the specific program.

b. Before we begin a discussion on risk and uncertainty, some pertinent definitions are relevant to the discussion.

(1) Budgeting to Most Likely Cost: This represents the most likely or most probable estimate of the cost that will ultimately be realized for a program, project, or task. An essential characteristic of the estimate should be that it includes the funding necessary to ensure that the program can be executed in an environment of undefined technical complexity, schedule uncertainty, and the associated cost risk. Furthermore, such risk funds should be an integral part of the estimated cost of each work breakdown structure (WBS) element that has risk or uncertainty. The risk funds are not management reserve, nor are they an identifiable or traceable element of cost. As a rule, more of the risk funds are budgeted in the development phase than in the production phase of a program. Factors bearing on risk include the phase of the acquisition cycle, the amount of concurrency between development and production, system complexity, etc.

(2) Management Reserve (MR): The use of this term is limited to cost type contracts that require cost/schedule control system criteria (C/SCSC) reporting. It represents a budget value within the negotiated contract target cost that contractors have decided not to initially distribute to their cost account managers. Contractors are required to track the application of MR. In addition, they are required to report the amount of MR in their financial reports submitted to the government.

(3) Engineering Change Orders (ECOs): ECOs are our best estimate for anticipated product changes and are based on such things as historical precedence, (e.g., safety of flight, correction of deficiencies, and value engineering). ECOs are a reserve for known or unknown contract changes. ECOs do not include reserves for "requirements creep," but are rather a reserve over and above allowances for risk. ECOs are an identifiable and traceable element of cost. ECOs apply to both development and production phases and vary by program and by fiscal year within a program.

3. Risk and uncertainty

a. Major Elements of Risk. Experts disagree on the sources of uncertainty in systems acquisition. In one of the first cost risk studies, Fisher[4] identified two categories of uncertainty--requirements and cost estimation. In a later study, Garvey[5] proposed three categories of uncertainty--requirements (or configuration) uncertainty, technical (or system definition) uncertainty, and cost estimation uncertainty. When PMs address risk in their acquisition strategy, they are primarily concerned with the *performance (technical), schedule* and *cost estimation uncertainties* of the system because these are the categories that determine the risk and uncertainty in a program and are those that the PM must identify and manage. To complicate matters, the risks and uncertainties associated with performance, schedule and cost estimating are not independent but exhibit a correlation among each other. For example, an increase in performance risk also impacts schedule risk, and an increase schedule risk may increase cost estimating risk. Good acquisition strategies attempt to identify and assess all sources of risk pertaining to their program. When cost analysts quantify risk, they begin by examining these same three areas--performance (requirements or technical), schedule, and cost estimating uncertainty. Since PMs must address the risks associated with these aspects of their acquisition strategies, we will examine the sources of uncertainty as they relate to performance, schedule and cost estimation.

b. Risk vs. Uncertainty. Before we proceed further, clarification of the technical distinction between the terms *risk* and *uncertainty* is needed. A *risky* situation is defined as one in which the outcome is subject to an uncontrollable random event with a known probability distribution. An example would be the expected *chance* failure of a component. We know that when events are purely random, as they are in chance failure, the times between successive events can be described by an exponential distribution. If we know the mean time between failure (MTBF) for the component, based on *repeated* observations from past experience, then the probability that the component will fail can be calculated.

An event is *uncertain* if the probability distribution of the uncontrollable event is unknown; in other words, if we have had no past experience (data) with which to establish a probability distribution of the outcome of the event, we are unable to predict the probability of an outcome without first performing a number of repeated experiments to establish a distribution. Since a defense system is unique and is built only once, there are no repeated experiments to which the system can be subjected -- a necessary condition for the computation of known probabilities. For this reason, when PMs address risk assessment, they are almost always working in the realm of uncertainty and when we discuss *cost risk*, we may be using the

terms *risk* and *uncertainty* indiscriminately and may really be discussing *cost uncertainty.* (For purposes of this discussion, please note that *cost uncertainty* is not used in the same context as *cost estimating uncertainty,* which will be discussed later.)

c. Point Estimates vs. Interval Estimates. Development of a cost estimate usually involves the application of a variety of techniques to produce an estimate of the individual elements' costs. The summation of these costs becomes the singular, best (and most likely) estimate of the total system cost and is referred to as a point estimate. In and of itself, the point estimate provides no information about uncertainty other than that it is the value judged more likely to occur than any other value. A confidence interval, on the other hand, provides a range within which the actual cost is expected to fall given the confidence level specified. For this reason, the cost analyst can best quantify cost uncertainty (or risk) by assigning a probability to all of the possible outcomes of an event and a consequence if the risk becomes a reality.

d. Uncertainty in Decision Making.. Most people have a practical understanding of the impact that chance can have on the outcome of an event. When estimating the likelihood of an event, we frequently describe the event using such language as "probable" or "likely." The study of random events and random processes falls under the subject of probability theory. Most of us, at one time or another, have unknowingly referred to the principles of classical probability theory when we have asked such questions as "What is the probability that some event will happen?" The point estimate provides a best single value, but with no consideration of uncertainty. The interval estimate provides significant information about the uncertainty, but little about the single value itself . It is when the interval is taken, together with the point estimate, that the best results are obtained and yield the most valuable information to the decision-maker. Given a point estimate and a confidence interval, it is the decision-maker's disposition toward risk that determines the alternative selected. Here the uncertainty information provides the means for the decision-maker to select between alternatives.

e. Budget Realities. Establishing the funding level for a program or system is one of the primary purposes for developing an estimate. Unfortunately, the budgeting process is not designed to accommodate an interval estimate, which means that a single monetary value must be chosen. In most cases, the point estimate is not selected as the budget since it does not reflect any adjustments for uncertainty or circumstances beyond the realm of the cost estimate. Since it is likely that the choice will be somewhere between the point estimate and the upper level of a conservative interval estimate, an obvious concern becomes the selection of a value reflective of external constraints and the cost uncertainty of the estimate. This is where the cost analyst can assist the manager in arriving at the best decision by providing uncertainty information for various budget values.

One of the most effective methods of portraying the uncertainty of an alternative is to depict the estimate and its related uncertainty in the form of a cumulative probability distribution. The usefulness of this approach is the easy-to-understand, convenient manner in which the information is presented to the decision-maker enabling them to easily see the implications of any particular choice.

4. Requirements for risk assessment and management

Today's weapon systems are increasing in technical complexity and this increases technical risk. Increased technical risk increases the risk of schedule delays and cost overruns. If you, as the cost analyst, are required to provide an estimate of a system's cost risk, one of your first considerations should be to

examine how the program office is managing risk. You will need to examine the Cost Analysis Requirements Description (CARD) and interview the PM Office's (PMO's) risk management team to determine how actively risk is being assessed and managed. The more proactively and aggressively risk is being managed, the less impact risk will have on the system's cost. Some things the analyst should consider include the following:

a. Risk Assessment Methodology. Most decisions a PM makes are heavily biased toward cost and schedule goals. While cost and schedule are two easily understood concepts, the impact of cost and schedule decisions and their relationship to performance, or technical, risk are usually not as apparent. For this reason, a formal method for evaluating the impacts of foreseeable problems upon cost, schedule and performance is essential if decision-makers are to make informed choices.

Many PMs use intuitive reasoning as the starting point in their decision-making process. The astute manager will go beyond intuitive reasoning or personal experience when making decisions which involve risk. At a minimum, the PM should attempt to identify all high risk components or processes, and determine the level of risk and the impact of that risk on the progress of the program.

b. Risk Management Activities. Major program acquisition strategies may include a series of "plans" that provide the rationale and intended processes for program execution. A risk management plan (RMP) is a sensible part of this series of guiding documents. The RMP may include the results or latest status of the risk management planning process and may also suggest items or activities that need to be addressed in the other plans. The following outline suggests the types of information a cost analyst may obtain from the RMP:

(1) System description and program summary. This section provides a technical description of the system, its mission, and current status.

(2) Approach to risk management. Under this heading would be the intended approach for executing the processes of risk assessment, risk analysis and risk handling. Also appropriate would be the definitions, measurement and rating techniques used for the technical, programmatic, supportability, schedule, and cost estimating risks.

(3) Application issues and problems. This section should include the procedures and processes for identifying and quantifying risk, the tools used to analyze risk, and the specific actions which would be applied to manage risk.

(4) While the RMP addresses the analysis and management of risk, risk may also be identified and highlighted in any or all plans where it is appropriate. Therefore, the cost analyst should review all other program plans, as these plans may provide information that will enable the cost analyst to raise risk questions. The cost analyst should review these plans before, during, and after preparation of the cost risk estimate.

One set of useful guidelines, which the analyst may use in assessing the PM's management of risk, has been provided by Fairley[2] who suggests that certain actions be implemented to manage risk. Using Fairley's guidelines, the cost risk analyst should determine if there is evidence that the PMO has taken action to:

(1) Identify risk. A risk is a potential problem. A problem is a risk that has materialized.

(2) Assess risk probabilities and effects on the project. Does the RMP provide an estimate of the two elements of a risk--the probability that the risk will become a problem and the effect the problem would have on the project if it materializes? Remember, the primary goal of risk management is to identify and confront risk with enough lead time to avoid a crisis.

(3) Develop strategies to mitigate identified risks. Has the PM set a threshold, beyond which some corrective action will be taken? Has a determination been made, ahead of time, what that corrective action will be? Do you, the risk analyst, see evidence of two types of strategies--*action planning* and *contingency planning*? Action planning addresses risks that can be mitigated by an immediate response. Contingency planning addresses risks that require monitoring for some future response should the need arise.

(4) Monitor risk factors. Has the PMO identified a person, or team, to monitor a component's risk metrics to ensure the data is objective, timely, and accurate?

(5) Invoke a contingency plan. Has the PM demonstrated a proclivity to invoke a contingency plan immediately when a quantitative risk indicator crosses a predetermined threshold? If the team could not solve the problem within the specified period, did the PM invoke a crisis-management plan?

(6) Manage the crisis. Does the PM have some plan for seeing a project through a crisis, including the allocating of sufficient resources and specifying a drop-dead date, at which time management will reevaluate the project for more drastic corrective action?

(7) Recover from the crisis. After a crisis, did the PM reward and recognize personnel and re-evaluate the PMO's cost and schedule estimates?

There is no getting away from risks. There is only recognizing them, managing them, and deciding which ones can be taken. The most successful risk managers are managers whose strategies for risk are proactive rather than reactive.

5. Elements of risk

Risk identification is the first step in the risk assessment process. Risks cannot be assessed or managed until they are identified and described in an understandable way. Risk identification should be an organized, systematic approach to identify the real risks associated with the program. Risks may be identified through such efforts as expert interviews, analogy comparisons, and the evaluation of the program plans. The object of risk identification is to enable the cost risk analysts to include in their cost risk estimates a straightforward narrative that describes the anticipated program risks and their expected value. Areas the cost analyst may examine for their potential impact on cost risk include:

a. Performance Related Risks. The major risks that can impact on program performance are requirements uncertainty. Requirements uncertainty is a major source of uncertainty in the cost analysis of military systems and total force structure proposals. Requirements uncertainty may include such factors as:

(1) Technical risk. Technical risk can be defined as the risk associated with evolving a new design to provide a greater level of performance than previously demonstrated. How much risk is added by

changes in performance requirements depends upon the maturity of the technology used to meet those requirements. Obviously, if requirements can be met using existing technology, then risk is considerably less because the technology has a performance history which can be used to predict the performance of the new system. If performance requirements can only be met through the development of a new or emerging technology, then the risk becomes much greater because technology becomes an unknown with no solid foundation for predicting its attainability.

(2) Configuration uncertainty. Configuration uncertainty is defined as the risk associated with changes in the physical or performance characteristics of a system. The primary reason for this uncertainty is the changes to the configuration of a system that occur during the system's life cycle. Configuration may change for a number of reasons:

(a) The original design may fail to produce the desired performance characteristics and have to be changed.

(b) The performance characteristics themselves may be changed with a resulting change in hardware specifications.

(c) A change in system specifications may be introduced purely by error or omission in establishing the initial requirements.

(d) The strategic situation may change, thus affecting the method of deploying and employing the system.

Although sometimes desirable, all of these changes can lead the project beyond its original intended scope and requirements. For this reason, a distinction must be made between *necessary* from *nice to have* changes because of the latter's adverse effect on project cost and schedule objectives.

(3) Supportability risk. Supportability risk is defined as the risk associated with fielding and maintaining systems that are currently being developed or have been developed and are being deployed. The ten Integrated Logistic Support (ILS) elements are the potential sources of supportability risk. They include:

(a) Maintenance planning,
(b) Manpower and personnel,
(c) Support equipment,
(d) Technical data,
(e) Training,
(f) Training support,
(g) Computer resources support,
(h) Facilities,
(i) Packaging, handling, storage, and transportation
(j) Design interface

The PMs address how they plan to manage supportability risk in their acquisition strategy. One of the most effective strategies for reducing supportability risk is to involve logistics support personnel in the early concept and design planning phases of the acquisition process.

(4) Programmatic risk. Programmatic risk can be defined as those risks which are outside the

program's control, but can affect the program's direction. Programmatic risks tend to be a function of the business environment and may include such sources as:

(a) decisions made at higher levels of authority regarding the program,

(b) indirect events or actions affecting the program,

(c) inability to foresee production related problems,

(d) other unforeseen imperfect capabilities.

A survey of program management offices indicates that directed funding cuts most often are viewed as the source of programmatic risk having a major impact on program execution.

b. Schedule Related Risks. Schedule duration is affected by requirements and cost changes and for this reason, the schedule risks may be acerbated by the degree of requirements and cost estimating uncertainty. For example, any change in system specifications, design requirements, or strategy may require a rework of design efforts and delay milestone approval. Changes in the monetary resources available may require a change to the schedule. In short, any event that may change the time schedule should be considered an uncertainty and be addressed as an element of schedule risk in the acquisition strategy.

A quality schedule is critical for the effective planning, implementing, and controlling of any program. A quality schedule is essentially a plan of action that is goal oriented. It should include activities and events which must be accomplished to achieve the desired objective. The techniques of program evaluation and review technique (PERT) and critical path method (CPM) have proven to be extremely valuable to PMs in managing their program management responsibilities. The output of the network risk analysis process generally provides an in-depth understanding of the sources and degree of risks and can be a valuable source of information for the cost risk analyst in their efforts to quantify schedule risk.

c. Cost Estimating Risks. In addition to the relationship of cost estimating uncertainty to performance and schedule uncertainty, a number of additional sources of cost *estimating* uncertainty must be addressed by the cost risk analyst. According to Fisher[3], *cost estimating uncertainties* may arise due to:

(1) Differences in individual cost analysts. Even if the analysts are of comparable competency, variations in cost estimates will arise because of individual differences in interpreting requirements, and differences in methodologies and techniques.

(2) Errors in cost estimating relationships (CERs). Actual costs can be expected to deviate somewhat from the predicted costs. Usually CERs are expressed in terms of a dependent variable being a function of one or more independent variable such that $g = f(x_1, x_2)$. These CERs cannot be assumed to hold exactly since they are developed using a statistical technique. Because they are a function of some independent variable, we cannot assume that these relationships will predict cost exactly.

(3) Errors in data. Observations used in deriving CERs invariably contain errors, even if these data come from carefully kept historical records.

(4) Extrapolation errors. In costing systems, analysts often use CERs derived from past experiences. We cannot be assured that a structural relationship that held in the past, or holds reasonably

well now, will continue to hold satisfactorily in the future and for the system being costed.

(5) Price-level changes. Usually cost estimates are made in constant dollars. In this case, price level uncertainty is usually not a factor. However, any time estimates for future systems are made in terms of price levels expected to prevail in future years, there is obviously a potential for future price levels to turn out differently than originally expected.

(6) Errors due to aggregation. Cost estimating errors may occur because of an estimating method that uses a considerable amount of aggregation.

Generally, true cost estimating and schedule risks are few when the source of the risk is well known. More often than not, cost estimating and schedule uncertainty are a reflection of technical, programmatic, and supportability risks.

6. Approaches for estimating cost risk

Several approaches are available for estimating uncertainty in a cost estimate, ranging from very subjective judgment calls to complex statistical approaches. This section provides an insight into the more fundamental and traditional techniques that form the basis for current field use. The order of presentation of these techniques is intentional to portray the evolution that has taken place in terms of the tools used to handle uncertainty.

Before beginning actual discussions of the uncertainty approaches, there are a few points for an analyst to keep in mind. First, to the extent actual historical cost information has been used in developing the point estimate, that data already includes the realities of both requirements and cost estimating uncertainty. This leads to a natural question of why there is any need to separately treat uncertainty. The need appears to come from the view that a point estimate includes an inherent amount for expected uncertainty. There is a bias toward hedging one's bet to the cautious side by adding an amount to the point estimate to cover uncertainties over and above what might be expected. Other than lacking the specific precision of statistics, this is not any different than adding some number of standard deviations to the mean to arrive at a higher specified level of confidence. A second point to keep in mind is whether cost estimating uncertainty, schedule uncertainty, or requirements uncertainty are to be addressed because the approaches discussed are more appropriately used in some situations than in others. Several of the approaches discussed here require the analyst to provide a highest and lowest possible value. The point becomes one of knowing whether these values presume a fixed baseline and, therefore, only reflect cost estimating uncertainty or whether they reflect possible variations of the baseline itself. Whatever the case, it must be clearly communicated so that the decision maker knows exactly what is included in, or excluded from, the estimate.

a. Subjective Estimator's Judgment. This is perhaps one of the oldest methods of accounting for uncertainty and, in some respects, is the basis for most other approaches. Under this approach the analyst merely reflects back upon the assumptions and judgments that were made during the development of the estimate. After evaluating all of the influencing parameters, a final adjustment is made to the estimate--usually as a percentage increase. This yields a revised total cost, which explicitly recognizes the existence of uncertainty. The logic to support this approach is that the analyst is more aware of the uncertainty in the estimate than anyone else--especially if the analyst is a veteran of the estimating wars and has experience in systems or items similar to the one being estimated. Analysts may use a questionnaire to arrive at their

subjective judgments. For example, an individual or team of analysts may answer questions such as:

1. What cost has an equal chance of being greater than or less than the actual cost (this gives the median or 50 percent probability level)?

2. What is the greatest possible cost of the project (this gives the 100 percent probability level)?

3. What cost is just as likely to be above the 50 percent probability level as it is to be below the 100 percent probability level (this gives the 75 percent probability level)?

4. What cost is just as likely to be above the 75 percent probability level as it is to be below the 100 percent level (this gives the 87.5 percent probability level)?

b. Expert Judgment/Executive Jury. Regardless of how subjective judgment is determined, there comes a time where the complexity and sophistication of the defense item is beyond the analyst's subjective assessment abilities. One method to overcome this is to use the expert judgment/executive jury technique. This technique is a variant of the estimator subjective judgment where an independent jury of experts is gathered to review, understand, and discuss the system and its costs, with the specific objective that from their collective deliberation will come some measure of uncertainty that can be quantified into dollars and used to adjust the point estimate cost. The strengths of such an approach are directly related to the diversity, experience, and availability of the group members.

The use of such panels or juries requires careful planning, guidance, and control to insure that the product of the group is objective and reflects the best unmitigated efforts of each member. Approaches have been designed to contend with the group dynamics of such panels. One classical approach is the Delphi technique, which was originally suggested by the RAND Corporation. The principle drawback of Delphi is that it is cumbersome. The time spent in processing inputs may present some difficulty to respondents.

Much literature has been written on expert opinions and subjective judgments. A good paper, which succinctly summarizes current philosophy and practice, was written by Spetzler and Von Holstein[8] in 1975.

c. Sensitivity Analysis. Another common approach is to measure how sensitive system cost is to variations in non-cost system parameters. For instance, if system weight is a critical issue, then weight would be varied over its relevant range and the influence on cost could be observed. Analysis of this type helps to identify major sources of uncertainty and provides valuable information to the system designer in terms of highlighting elements that are cost sensitive, areas in which design research is needed to overcome cost obstacles to achieving better program performance, and areas in which system performance can be upgraded without substantially increasing program cost. The traditional criticism of this procedure is that it does not reveal the extent to which the estimated system cost might differ from the actual cost. That is, it tends to address requirements uncertainty more than cost estimating uncertainty.

d. High/Low Analysis. The high/low analysis approach requires the analyst to specify the lowest and highest possible values for system element costs, in addition to their most likely values. These sets of input values are then summed to give total system cost estimates. The most likely values establish the central tendency of the system cost, while the sums of the lowest possible values and highest possible values determine the uncertainty range for the cost estimate. Although this approach has a logical appeal, it tends to greatly exaggerate the uncertainty of system cost estimates because it is unlikely that all system

element costs will be at the lowest (or highest) values at the same time. While the high/low approach is plausible, its shortcoming is that it restricts measurement to three points without consideration to intermediate values or their likelihood. The approaches described in the next paragraph provide solutions to this shortcoming.

e. Mathematical Approaches. If the individual cost elements can be regarded as random variables and their distributions can be determined, then the system cost can also be expressed as a probability distribution around an expected value. This is the basis for mathematical approaches. These approaches simply improve upon the high/low approach by providing a probability distribution for each cost element. To do so first requires the solution of two distinct problems: (1) how to determine the probability distribution for each cost element, and (2) how to combine the individual cost elements and their measures of uncertainty into a total estimate of cost and uncertainty (the summation of moments and Monte Carlo simulation are possible solutions to this problem). Some guidelines for resolving the problem of identifying the appropriate distribution follow.

(1) *The Beta Distribution* - This distribution is particularly useful in describing cost risk because it is finite, continuous, can easily accommodate a unimodal shape requirement, ($\alpha \geq 0$, $\beta \geq 0$), and allows for virtually any degree of kurtosis and skewness. The values of α and β are the shape parameters, and each combination produces a unique shape. However, the process of deriving the appropriate values for a particular shape can be quite involved. Fortunately, a few observations about α and β lead to a rather useful approach in approximating the appropriate values. In the case of skewness, when α and β are equal, the distribution is symmetric, when $\alpha > \beta$, the distribution is negatively skewed, and when $\alpha < \beta$, the distribution is positively skewed. Similarly, variance (kurtosis) can be categorized as high, medium, or low based upon the magnitude of α and β. When these notions of skewness and kurtosis are combined, the result is nine combinations as shown in Table 1. These nine types tend to be fairly descriptive of most situations an analyst might confront. Analysts can choose the distribution which best approximates their

Table 1 Beta Shape Combinations

Combination Type	Skewness	Kurtosis	α	β
1	Negative	High	1.50	0.50
2	Symmetric	High	1.35	1.35
3	Positive	High	0.50	1.50
4	Negative	Medium	3.00	1.00
5	Symmetric	Medium	2.75	2.75
6	Positive	Medium	1.00	3.00
7	Negative	Low	4.50	1.50
8	Symmetric	Low	4.00	4.00
9	Positive	Low	1.50	4.50

subjective view of the cost element uncertainty without having to derive α or β. It should also be noted that these nine distributions limit the location of the mode to the first, second, or third quartiles of the distribution range. In the case where the analyst specifies only the lowest and highest value and has identified the parameters, α and β, the most likely (ML) value can be calculated as in Equation 1:

$$ML = \frac{\alpha\ (H) + \beta\ (L)}{\text{----------}} \qquad \text{(Eq. 1)}$$

$(\alpha + \beta)$

Obviously, one shortcoming of the beta distribution is that it is difficult to specify α and β because there is no literal interpretation for these parameters as there are many possible Beta distributions for a given set of high, low, and most likely values. One way to overcome this shortcoming is to use the PERT beta distribution (see Table 2, below). Under the assumption of a PERT beta distribution, the mean and variance can be estimated without identifying the parameters, α, and β, of the distribution. In any case, analysts should only use the beta distribution if they are very comfortable with the highs, lows, and most likely values.

(2) *The Triangular Distribution* - An alternative approach to assigning a beta distribution shape to a cost element is the triangular distribution. Like the beta, it can take on virtually any combination of skewness and kurtosis but is represented by a triangle rather than the smoother curve of beta distribution. The triangular distribution is specified by the lowest, most likely (usually the point estimate), and the highest value. Any point within the range of the distribution can be chosen to locate the mode, and the relationship among the three values specifies the amount of kurtosis. Given the selection of the values and the triangular shape inherent to those values, both the mean and the variance can be calculated as shown in Table 2.

In contrast to the beta distribution, the triangular distribution is much easier to use and produces equally satisfactory results. For this reason, the triangular distribution is preferred by many analysts over the more common beta distribution.

(3) *The Lognormal Distribution.* The lognormal distribution results when the logarithm of the random variable is described by a normal distribution. That is, if X is lognormally distributed, then $Y = \ln X$ is normally distributed. The lognormal distribution applies as the limiting case for multiplicative quantities due to the approach to normality of the sum of the logs. The distribution is often found to provide a good representation for physical quantities that are constrained to being non-negative, and are positively skewed, such as pollutant concentrations,, stream flows, spill quantity, etc. The lognormal distribution is particularly appropriate for representing large uncertainties that are expressed on a multiplicative or order-of-magnitude basis.

(4) *The Normal (Gaussian) Distribution.* The normal, or Gaussian, distribution arises in many applications, in part because of the central limit theorem, which results in a normal distribution for additive quantities, and in part because of its well studied and frequent use in classical statistics. The normal distribution is commonly used to represent uncertainty resulting from unbiased measurement errors and is quite useful, for example, for estimating system failure due to a part wearing out. Fortunately, wear-out failures are quite predictable and are modeled quite well by the normal distribution because they cluster around a mean failure time and tend to be symmetrically distributed. If we take the probability density function, f(x), of a normal distribution, and substitute time (t) for the variable (x) and the MTBF (m) for the mean (μ), we can measure the probability of wear-out failure over any time interval by integration.

(5) *The Exponential Distribution.* When events are purely random (e.g., chance failure of a component), the times between successive events can be described by an exponential distribution. The parameter of the distribution, λ, is equal to one divided by the average time between events, and is thus equivalent to the occurrence rate of the process. Therefore, the exponential distribution is most appropriate for estimating *chance* failure of systems to arrive at the operations and support costs of components because the range of the exponential distribution is from $t = 0$ to $t = \infty$. This range corresponds nicely with

the interpretation of "t" representing time and can be used to model chance and early failures.

(a) Chance failure. The exponential distribution is very useful in the case of chance failure if we know what the failure rate is. We need only to divide the number 1 by the failure rate to find the MTBF. For expositional convenience, MTBF can be represented by the lower case letter "m". To recap, the reliability of a component subject *only* to chance failure then becomes:

$$R(t) = 1 - e^{-\lambda t} = e^{-t/m} \qquad \text{(Eq. 2)}$$

(b) Early failure. Early failure results from the production of substandard components which are unable to withstand ordinary operating stresses. As a result, the substandard components have a very high failure rate which follows the exponential distribution and are, therefore, similar to chance failures except that their failure rate is much higher. The reliability impact of early failures depends directly upon whether or not we can assume that defective parts will be replaced with good ones. If we make that assumption and further assume that we start with N components, N_G of which are good, and N_B of which are bad, initially the failure rate will be:

$$\text{System Failure Rate} = N_G\lambda_G + N_B\lambda_B, \qquad \text{(Eq. 3)}$$

where λ_G is the chance failure rate. As the defective parts are replaced with good parts, the failure rate of the system will converge to the chance failure rate which characterizes the good parts.

Whichever distribution the analyst selects to model the risk, once the distribution shapes have been identified for each cost element (or group of elements), the next step is to find the expected value (mean) and measure of uncertainty (variance) for the total system cost. This can be done in one of two ways.

(1) *The Method of Moments* - This method takes its name from the fact that one particular method of measuring or describing a distribution is through the use of moment statistics. The first moment is the mean, the second is the variance, and the third, and fourth moments are used to calculate two measures which provide additional insight into the shape of a particular distribution. These last two moments are the coefficient of skewness, which provides a measure of symmetry, and the coefficient of kurtosis, which measures the peakedness or "height" of a distribution. An acceptable method, using judgments, to compute the mean and variance of some common distributions is summarized in Table 2 below.

Table 2 Estimating the Mean and Variance of Some Common Distributions

DISTRIBUTION	MEAN	VARIANCE
UNIFORM	Mean = (high+low) / 2	Var = [(high - low)^2] / 12
TRIANGULAR	Mean = (a + b + c) / 3 *	Var = (a^2 + b^2 + c^2 -ab-ac-bc)/18*
NORMAL (Gaussian)	Mean = most likely	Var = [(high - low) / 6] ^{2}
BETA	Mean = [low + 4 (most likely) + high] / 6	Var = [(high - low) / 6] ^{2} (known as "PERT beta")
TOTAL COST	$\mu_T = \Sigma \mu_i$, where i = 1, 2, 3, ...	$\sigma^2_T = \Sigma_i \sigma^2_i + 2\Sigma_i\Sigma_{j<i}\,Cov_{ij}$

* where: a = low, b = high, and c = most likely

The relevance of moment statistics to the development of a measure of total system cost uncertainty hinges upon the fact that the moment measures for each cost element can be summed to produce the moment measures for the total system cost, when the variables (cost elements) are independent. If, for some reason, independence among variables does not exist, then the covariance of the interdependent variables must be incorporated in estimating the moment of the sum. For instance, the system mean is the sum of the individual element means; the variance (second moment) of the sum of independent variables is equal to the sum of the variances; etc. Some authors use only the first and second moments to arrive at a measure of uncertainty. That is, with both the mean and variance of the total system cost determined through the summation process, the standard deviation is directly computed and the total cost portrayed as either a normal probability distribution or cumulative density distribution. The critical assumption in this approach is that even though the individual cost element distributions may not be normal, the total cost distribution will be. The basis for this normality assumption is the central limit theorem and a sufficiently large number of individual cost elements. However, it is possible that if the variance of the distribution for an individual cost element is an order of magnitude greater than the others, it may dominate the resulting aggregate distribution which may then take on any of the non-normal characteristics of the dominant cost element. When this or any other condition occurs which might jeopardize the central limit assumption, the Monte Carlo Simulation approach described in the following paragraph offers a better solution. Some useful descriptions of probability distributions and their parameters are summarized in Table 3.

Table 3 Descriptive Parameters of Probability Distributions

DISTRIBUTION	PARAMETERS	MODE	MEDIAN	MEAN
TRIANGULAR	L, M, H	M	$H-[(H-L)(H-M)/2]^{1/2}$ * $L+[(H-L)(M-L)/2]^{1/2}$ **	(L+M+H)/3
NORMAL (GAUSSIAN)	μ, σ	μ	μ	μ
LOGNORMAL	P, Q	$e^{P-Q\hat{}2}$	e^{P}	$e^{P+.5Q\hat{}2}$
EXPONENTIAL	L, λ	L	$L + (\ln 2/\lambda)$	$L + (1/\lambda)$
UNIFORM	L, H	NONE	(L+H)/2	(L+H)/2

* IF H-M $\geq$ M-L (Right Skew)

** IF M-L $\geq$ H-M (Left Skew)

(2) *Monte Carlo Simulation* - An alternative to the method of moments is to use the Monte Carlo simulation. With this approach, the distribution defined for each cost element (using a beta, triangular, or empirical distribution) is treated as a population from which a random sample is drawn. The sample values for each element are summed to a total cost and then the entire process is repeated again. This procedure is repeated many times (e.g.100-1000). The result is a distribution of total cost which can be described by its mean and standard deviation and portrayed as a cumulative distribution.

The question of independence versus dependence arises. Realistically, it is quite unlikely a total system cost either consists of completely dependent or independent cost elements. Nor does there appear to be a consensus on which assumption to make. One position holds that the only estimating errors meeting the criteria of randomness are cost estimating uncertainties and, therefore, the assumption of independence is reasonable for cost estimating uncertainty only. Dependence appears to be more of a concern when cost and requirements uncertainties are considered jointly or when requirements uncertainty is considered alone. That is, requirements variations tend to be viewed more like "bias errors" than the "noise" normally associated with randomness. If, for some reason, the analyst determines that independence among variables does not exist, then the covariance of the interdependent variables must be incorporated in estimating, whether the summing is by the methods of moments or by Monte Carlo simulation.

This concludes the discussion on the methods for dealing with uncertainty. The discussion was not intended to be exhaustive, but rather to provide an insight into the "how" and "why" of selected methods prominent in some cost offices. Before proceeding to the next section, there is an additional point that needs to be made. Rarely is there enough data available to generate a frequency distribution that can be used like those in textbook examples. However, analysts can try to approximate distributions through the use of some of the techniques discussed in this section.

7. Software Models for estimating uncertainty

a. Automated Cost Estimating Integrated Tools (ACEIT). ACEIT is an estimating system containing tools to assist in conducting cost analysis activities including risk and uncertainty analysis. A major function of ACEIT is the RI$K model which quantifies risk associated with a cost estimate. The primary solution method of RI$K is based on Monte Carlo simulation and is appropriate for cost uncertainties that can be characterized as probabilistic in nature. One advantage to using RI$K is that it is structured around the WBS specified during the development of the ACEIT cost estimate.

b. Crystal Ball. Crystal Ball is a risk analysis spreadsheet add-in that lets users conduct what-if scenarios with Excel spreadsheet values/cells. The program examines the degree of risk in forecasts by using Monte Carlo techniques that allow Crystal Ball to forecast all statistically possible results for a given situation. Users apply either a range of values or a probability distribution to each cell containing an uncertain number. The model generates random values for each cell according to the parameters given by the user. The software displays the distribution of results showing the highest, lowest, and most likely values. This software is best used when the analyst has some idea of the distribution and the values of the distribution parameters. The software is one of the best for addressing correlation between elements and can be used to estimate technical, schedule, and cost estimating uncertainty. This model is taught in the Graduate Cost Analysis Program at the Air Force Institute of Technology (AFIT).

c. @RISK. @RISK is a Lotus 1-2-3/Microsoft Excel (PC or Macintosh) add-in for risk analysis. Any worksheet built in 1-2-3 or Excel can be used with @RISK. The software uses Monte Carlo simulation to analyze uncertainty. Probability distributions are added to cells in the worksheet using any of the more than 30 built-in probability distribution functions, including: normal, log normal, beta, uniform, and triangular. Simulations are controlled from a Lotus/Excel-style menu that lets users choose Monte Carlo or Latin Hypercube sampling, select output ranges, and monitor convergence. Results are displayed graphically, and detailed statistical reports are generated. The software is also capable of handling correlated cost elements and is more appropriate when the analyst has a number of data points, but is unsure of the distribution to model. The PC Excel version of @RISK is taught at the Army Logistics Management College (ALMC).

d. The Cost Analysis and Strategy Assessment (CASA) Model. The CASA model was developed by Honeywell for the Defense Systems Management College in 1986. The CASA model allows the user to generate data files, perform Life Cycle Costing, sensitivity, and risk analyses. One limitation of the CASA model is that it overestimates operational availability because it ignores preventive maintenance.

e. Program Evaluation and Review Technique (PERT). The PERT is a commonly used network method for project planning, scheduling, and control. It was developed for application in projects where there is much uncertainty about the nature and duration of activities. PERT addresses schedule uncertainty by using three time estimates--*optimistic, most likely,* and *pessimistic.* The three estimates are related in

the form of a Beta probability distribution with parameters *a* and *b* as the end points, and *m*, the modal, or most frequent, value. These estimates are then used to calculate the "expected time" for an activity and the range between the estimates provides a measure of variability which permits statistical inferences to be made about project events at particular times.

Although it enjoys wide use, PERT has been widely criticized since its inception. For one thing, PERT statistical procedures provide overly optimistic results. Another major criticism is that PERT puts too much emphasis on the critical path. This leads managers to ignore other paths that are near-critical or have large variances, and which could easily become critical and jeopardize the project.

f. The Air Force Systems Command (AFSC) Risk Model. The AFSC Risk Model uses the beta distribution combined with Monte Carlo simulation to arrive at a system's estimated cost and uncertainty. RISK considers the median (50% point) to be the "best estimate of total cost." Point estimates below the median are considered high risk programs. Point estimates above the median represent programs with management reserve added as a hedge against cost risk.

g. Risk Plus. Risk Plus can be used to estimate schedule and software costs and their associated risks.

Again, the use of these, or any other models, requires a clear definition of what types of uncertainty are to be treated and how the specific model satisfies the requirement.

8. Summary

Accomplishing a program risk analysis can be a formidable task because there are few management analysis topics as abstract and complex as risk analysis. This chapter has introduced you to some general concepts, methodologies, and models pertaining to cost risk. For more information, references are provided at the end of this chapter.

Beginning risk analysts should approach a cost risk analysis as they would any problem. First become familiar with all existing knowledge on the system to be analyzed. Become familiar with the system and the Program Office Estimate (POE). Read all related documents such as the CARD, reports, program plans and by studying the cost estimate. Interview all persons who have knowledge of the program and its complexities and problems. Finally, look for answers to questions such as the following , that you may have formed during your research:

a. How good is the *PMO's identification and management of risk*? Is there a current tracking of risk areas? Do they have an abatement plan in place should the risk materialize? Consider all other issues raised in section 4 of this chapter.

b. Take a hard look at the *software estimate.* This area typically has one of the highest potentials for cost overruns. Is the PMO using software metrics to track software development efforts or is the developer telling them how well the development effort is progressing? Are development efforts on schedule? Have schedule problems been experience? What is the SEI maturity level of the software developers? What tools are they using? What is the defect ratio? What does current cost schedule control system criteria (C/SCSC) data tell you? Listen to the experts, but *form your own opinions.*

c. *Cost estimating risk.* Look at the estimating methodology. Does it appear sound and straightforward? Examine any "cost savings" or "cost avoidance" measures which are reflected in the estimate. These are risky areas and should be included in your cost risk. Examine the labor and inflation rates, learning curves, and all other assumptions made by the cost estimator. How did the analyst arrive at the point estimate? What was the range considered (minimum and maximum) before deciding on the point estimate? Use the range to establish your distribution for any cost risk analysis of components you have identified as containing risk or uncertainty.

d. *Schedule risk.* Is the program on schedule? If there are schedule overruns, what will be the cost impact? Don't forget that a schedule delay has a cost impact for all aspects of the program, including the SE/PM costs.

e. *Technical risk.* How is development progressing? Is technology state-of-the-art or is it current technology? Look at C/SCSC data. Based on the cost of work performed and the percent of work completed, what is the projected cost to complete? Look at sub-components and identify any technical risk of each. Remember, if you do a cost risk analysis at the sub-component level, you must use a Monte Carlo simulation model to sum costs. You cannot make an assumption on the total distribution, based on the distribution of sub-components. For example, when you sum two uniform distributions, the total sum is a triangular distribution! Also remember, when conducting a cost risk analysis of sub-elements, you must address any correlation between/among the elements. Otherwise your risk analysis will be invalid.

h. Were *environmental costs* included in the POE? Examine all phases, from Research, Development Test & Evaluation (RDT&E) to disposal, to ascertain that all environmental costs are included in the total life cycle cost of the system.

The fourth step will be to plan your strategy. Decide how you plan to quantify the cost risk based on the knowledge you have acquired. Now is the time to select the methodology and model you think will produce the best results.

Finally, you must devise a clear way to communicate the results. The best cost risk analysis is useless if the information is not stated in a format and language the decision-maker can understand.

In summary, keep in mind that the credibility of cost estimates is primarily governed by two factors: the soundness of estimating methodology and data availability. The following descriptors provide a basis for classifying Army cost estimates into seven data availability and four techniques classes. Experience has shown that, for an estimate, the higher these classes are on each list, the more confidence one can have in an estimate using the data and techniques specified.

a. Methods Used

(1) Detailed

(2) Detailed and Parametric

(3) Parametric and Factors

(4) Analogous and Factors

b. Data Availability

(1) Actual cost of significant quantities for the system being estimated arrayed by functional and WBS breakout.*

(2) Actual cost for development hardware for the system being estimated arrayed by functional and/or WBS breakout.*

(3) Actual cost by functional and/or WBS for analogous systems.*

(4) Firm contractors' proposals with detailed backup or negotiated prices.

(5) Contractor budgetary estimates with program office add-ons (factors, ECO, management reserve, etc.)

(6) Limited cost data but good descriptions of physical, technical, and performance characteristics.

(7) Limited cost data and limited physical, technical, and performance descriptors.

* If based on cost performance management report data, so state and report percent complete.

References

1. Defense Systems Management College. Risk Management, Concepts and Guidance, Washington: U.S. Government Printing Office, 1992.

2. Fairley, Richard. *Risk Management for Software Projects.* IEEE Software, Vol 11, No. 3, May 1994, pp. 57-67.

3. Fisher, Gene. *A Discussion of Uncertainty in Cost Analysis (A Lecture for the AFSC Cost Analysis Course)*, Memorandum RM-3071-PR, Contract No. AF 49(638).700 with The RAND Corporation, Santa Monica, CA, 1962.

4. Fisher, Gene. Cost Considerations in Systems Analysis, Contract DAHC 15 67 D 0150 with The RAND Corporation. American Elevier Publishing Co., NY, 1971.

5. Garvey, P.R. *A Family of Joint Probability Models for Cost and Schedule Uncertainties,* The MITRE Corporation, presented at the 27th Annual Department of Defense Cost Analysis Symposium, September 1993.

6. Morgan, M. Granger and Henrion, Max. Uncertainty. Cambridge University Press, New York, NY, 1990.

7. Sobel, S. A Computerized Technique to Express Uncertainty in Advanced System Cost Estimates. The MITRE Corporation, Bedford, Massachusetts, November 1965.

8. Spetzler, Carl S. and Von Holstein, Carl. "Probability Encoding in Decision Analysis." Management Science, Vol. 22, No. 3, Nov 1975, pp. 340-357.

9. Wilder, J. J. An Analytic Method For Cost Risk Analysis. Grumman Aerospace Corporation. July 1978.

10. Zelen, M. Bounds on a Distribution Function that are Functions of Moments to Order Four. Research Paper 256, National Bureau of Standards, Vol. 53, No. 6, Washington, D.C., December 1954.

APPENDIX L - DOD 5000.4-M KEY COST TERMS

The definitions for the seven key cost terms from DoD 5000.4-M are as follows.

1. Development Cost.

a. Work Break down Structure (WBS). WBS elements of Prime Mission Equipment, System Engineering/Program Management, System Test and Evaluation (except Operational Test and Evaluation funded from Military Personnel or Operation and Maintenance appropriations), Training, Peculiar Support Equipment, Data, Operation/Site Activation, and Industrial Facilities (when provisions of Chapter 251 of DoD 7110-1-M apply).

b. Budget. Funded from the RDT&E appropriation (i.e. concept exploration and definition, demonstration and validation, and engineering and manufacturing development phases from the point the program and/or system is designated by title as a Program Element or major project in a Project Element).

c. Life-Cycle Costs. The development costs, both contractor and in-house, of the Research and Development cost category, including the cost of specialized equipment, instrumentation, test, and facilities required to support the RDT&E contractor and/or Government installations.

2. Flyaway (Rollaway, Sailaway, etc.) Cost.

Flyaway cost is used as a generic term to refer to the cost of producing a usable end item of equipment (hardware and software). Flyaway cost includes:

a. Work Breakdown Structure (WBS). WBS elements of Prime Mission Equipment (such as basic structure, propulsion, electronics (hardware and software), system software, etc.), System Engineering/Program Management, and System Test and Evaluation.

b. Budget. Funded from RDT&E and Procurement appropriations. This would include funding for warranties, engineering changes, pre-planned product improvement (during system acquisition), and first destination transportation (unless FDT is separate budget line item). Certain acquisition costs funded in the O&M appropriation (e.g. ship installations) are also included.

c. Life-Cycle Cost. The flyaway costs (including Government Furnished Equipment), both contractor and in-house, of the Research and Development and Investment Nonrecurring and Recurring cost categories.

3. Weapon System Cost.

a. Work Breakdown Structure (WBS). WBS elements Prime Mission Equipment, System Engineering/Program Management, System Test and Evaluation (if funded by Procurement), plus WBS elements Training, Peculiar Support Equipment, Data, Operational/Site Activation, and Industrial Facilities (unless funded as a separate budget line item or by RDT&E).

b. Budget. Funded from the Procurement appropriation. It includes funding for warranties, engineering changes, pre-planned product improvement (during system acquisition), and first destination transportation (unless FDT is a separate budget line item). Certain acquisition costs funded in the O&M appropriation (e.g. ship installations) are also included.

c. Life-Cycle Cost. The weapon system costs (including Government-Furnished Equipment), both contractor and in-house, of the Investment Nonrecurring and Recurring cost categories.

4. Procurement Cost.

a. Work Breakdown Structure (WBS). The same WBS elements as in Weapon System Cost; i.e., Prime Mission Equipment, System Engineering/Program Management, System Test and Evaluation (if any of this effort is funded by Procurement), Training, Peculiar Support Equipment, Data, Operational/Site Activation, and Industrial Facilities (unless funded as a separate budget line item or by RDT&E), plus the WBS element: Initial Spares and Repair Parts.

b. Budget. Funded from the Procurement appropriation. It includes funding for warranties, engineering changes, pre-planned product improvement (during system acquisition), and first destination transportation (unless FDT is a separate budget line item). For Navy shipbuilding programs, outfitting and post delivery costs are also included when Procurement funded. Certain acquisition costs funded in the O&M appropriation (e.g. ship installations) are also included.

c. Life-Cycle Cost. The procurement costs (including Government Furnished Equipment), both contractor and in-house, of the Investment Nonrecurring and Recurring cost categories.

5. Program Acquisition Cost.

Program Acquisition Cost consists of Development Costs, Procurement Costs, and any construction costs that are in direct support of the defense acquisition program. It includes:

a. Work Breakdown Structure (WBS). WBS elements of Prime Mission Equipment, System/Program Management, System Test and Evaluation (except Operational Test and Evaluation funded from Military Personnel or Operation and Maintenance), Training, Peculiar Support Equipment, Data, Operational/Site Activation, Industrial Facilities (unless funded by Procurement as a separate budget line item), and Initial Spares and Repair Parts.

b. Budget. Funded from the RDT&E, Procurement, and MILCON appropriations. It includes funding for warranties, engineering changes, pre-planned product improvement (during system acquisition), and first destination transportation (unless FDT is a separate budget line item). Certain acquisition costs funded in the O&M appropriation (e.g. ship installations) are also included.

c. Life-Cycle Cost. The program acquisition costs (including Government Furnished Equipment), both contractor and in-house, of the Research and Development, and Investment nonrecurring and recurring cost categories.

6. Operating and Support (O&S).

a. All personnel, equipment, supplies, software, services, including contract support, associated with operating, modifying, maintaining, supplying, training, and supporting a defense acquisition program in the DoD inventory. This includes costs directly and indirectly attributable to the specific defense program; i.e., costs that would not occur if the program did not exist, such as:

(1) Mission Personnel. Pay and allowances for officer, enlisted, and civilian personnel assigned to support a discrete operational system or deployable unit. Includes personnel necessary to meet combat readiness, training, and administrative requirements.

(2) Unit Level Consumption. Fuel and energy resources; operations, maintenance, and support materials consumed below depot level; reimbursement of stock fund for depot level reparables; operational munitions expended in training; transportation of materials, repair parts and reparables between the supply or repair point and unit; and other unit level consumption costs such as purchased services for equipment lease and service contracts.

(3) Intermediate Maintenance. Labor, material, and other costs expended by designated activities and/or units (third and fourth echelons) performed external to the unit. Includes calibration, repair and replacement of parts, components or assemblies and technical assistance to the mission unit.

(4) Depot Maintenance. Personnel, material, overhead support, and depot purchased maintenance required to perform major overhaul, and maintenance of a defense system, its components, and support equipment at DoD centralized repair depots, contractor repair facilities, or on site by depot teams.

(5) Contractor Support. Labor, materials, and depreciable assets used in providing all or part of the logistics support to a defense system, subsystem, or related support equipment.

(6) Sustaining Support. Procurement (exclusive of war readiness materiel) of replacement support equipment, modification kits, sustaining engineering, software maintenance support, and simulator operations provided for a defense system.

(7) Indirect Support. Personnel support for specialty training, permanent changes of station, and medical care. Also includes relevant host installation services, such as base operating support and real property maintenance.

b. O&S costs are funded from Operation and Maintenance (O&M), Military Personnel, Procurement, Military Construction, stock funds, and other appropriations.

7. Life Cycle Cost.

Life Cycle Cost includes **ALL** WBS elements; **ALL** affected appropriations; and encompasses the costs, both contractor and in-house effort, as well as existing assets to be used, for all cost categories. It is the **TOTAL** cost to the Government for a program over its full life, and includes the cost of research and development, investment in mission and support equipment (hardware and software), initial inventories, training, data, facilities, etc., and the operating, support, and, where applicable, demilitarization, detoxification, or long term waste storage.

FINANCIAL ANALYSIS PRIMER

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FINANCIAL ANALYSIS PRIMER

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Chapter 1. PURPOSE OF FINANCIAL ANALYSIS

This Financial Analysis Primer is designed for managers and analysts who are interested in financial analyses. The Primer is not intended to provide detailed "how-to" instructions, but, instead, a discussion of the importance of financial analysis to the Army and various approaches to its accomplishment. The Primer assumes that the reader has a modest understanding of business, finance, and accounting activities.

Financial analysis is the process of analyzing financial performance through various analytical approaches and techniques. For purposes of this Primer, financial analysis is defined as an assessment of a company's past, present and projected future financial condition, with the objective of evaluating its financial ability to perform. Financial analysis is widely used in the private sector to determine credit worthiness, project budgets, develop corporate plans for mergers and acquisitions, and identify optimal investment opportunities.

In the Army acquisition environment, the primary objective of corporate financial analysis is to give the Army an indication of a firm's financial condition and ability to meet its contractual obligations in terms of cost, schedule and performance. Decision makers have long evaluated technical, management, and manufacturing capabilities of contractors. Today, the continuing reliance of national defense on private industry, coupled with vigorous competition for limited defense dollars, makes it critical for DoD to monitor the financial health of its contractors. Financial analyses are of considerable assistance during the source selection process, in negotiations with potential contractors, and at major milestone decision points in the materiel acquisition process. While the financial analyses normally will not be **the** deciding factor in these processes, they do require serious consideration.

Another area where financial analysis is gaining importance, is in the evaluation of potential mergers of defense contractors. With defense budgets expected to decrease even further through the end of the decade, mergers will increase in number. Antitrust agencies, such as the Justice Department and the Federal Trade Commission, will continue to make the ultimate decision on the competitive consequences of a defense industry merger, but the DoD has an important role to play in the process. Particularly if the potential merger is controversial, DoD support is critical. Financial analyses of the two former companies (or divisions) and of the projected new company are essential to DoD in determining an appropriate position and effectively influencing the outcome of the merger proposal.

Chapter 2. APPROACH TO FINANCIAL ANALYSIS

This Primer does not propose one "best way" to perform a financial analysis because the approach will depend on the objective of the analysis, time constraints, and availability of key financial data. In some cases, it is only possible (or necessary) to develop a quick study of a firm's financial health to answer an urgent question. In these instances, time constraints limit data collection (e.g., to a corporate annual report) and analysis must focus on only the most critical issues. When a comprehensive analysis is required and time is available, several additional data sources should be utilized, additional financial indicators may be examined, and more in-depth quantitative and qualitative analysis may be undertaken. This Primer includes two basic approaches to financial analysis, reflecting varying levels of complexity. Quick Response and In-Depth Analysis Approaches are discussed in *Representative Approaches to Financial Analysis.*

The approach also will vary with the analyst's selection of techniques for analysis. For example, ratio analysis, a primary tool of financial analysis, relates key elements from financial statements and makes possible meaningful comparisons of that data with data from prior periods and other companies. Although certain categories of ratios are relatively traditional, the particular ratios utilized are largely a matter of the issues to be decided or the analyst's preference. In one approach, this Primer utilizes Dun & Bradstreet's fourteen key business ratios, categorized as solvency, efficiency and profitability. In another approach, alternative pertinent ratios are used, grouped into the four basic categories of liquidity, activity, leverage, and profitability.

Finally, the approach to financial analysis depends on the availability of automation for performing calculations and displaying data. Because of the vast amounts of data necessary in assessing financial condition, a computerized technique for generating ratios and other calculations is important, as is a disciplined approach to data presentation. This Primer presents various automated report formats and information on retrieval of financial data from computer data bases.

Chapter 3. TOOLS FOR ANALYSIS

3.1. Ratio Analysis.

Ratio analysis comprises the principal tool of financial analysis, since it can be used to answer a variety of questions regarding a firm's financial well-being or assess its performance and status. The basic inputs to ratio analysis are the company's income statement and balance sheet for the fiscal periods to be examined. A ratio is the relationship between any two line items appearing in a firm's financial report (e.g., current ratio equals current assets divided by current liabilities).

Ratio analysis involves the calculation of selected ratios, as well as the more important interpretation of the ratio value. To determine whether a ratio is too high or too low, or good or bad, requires a meaningful standard or basis for comparison. Two general types of ratio comparisons can be made: cross-sectional and time-series. Cross-sectional analysis involves comparison of a firms' financial ratios to industry averages at the same point in time. This comparison is made to isolate any deviations from the norm. Large deviations to either side of the industry norm may be indicative of problems worthy of further investigation.

Time-series analysis involves evaluating a firm's financial performance by examining the same ratios for the firm over time. Developing trends can be seen by using multiyear comparisons. Another informative approach to ratio analysis is one that combines cross-sectional and time-series analyses. This view permits assessment of the trend in the behavior of the ratio in relation to the trend for the industry. Cautions in ratio analysis are discussed in *Limitations of Analysis and Cautions.*

3.2. Dun & Bradstreet's Financial Ratios.

Dun & Bradstreet's fourteen key business ratios are divided into three basic groups or categories: solvency, efficiency, and profitability. Solvency ratios measure a company's ability to meet short- and long-term obligations. Efficiency ratios indicate how effectively a company uses and controls its assets. Profitability ratios show how successfully a business is earning a return to its shareholders. Formulas for calculating these ratios are indicated below, followed by a discussion of what they measure and their importance.

Appendix M - Financial Analysis Primer

Solvency:

1. Quick Ratio = (Current Assets - Inventory) / Current Liabilities
2. Current Ratio = Current Assets / Current Liabilities
3. Current Liabilities to Net Worth = Current Liabilities / Net Worth
4. Current Liabilities to Inventory = Current Liabilities / Inventory
5. Total Liabilities to Net Worth = Total Liabilities / Net Worth
6. Fixed Assets to Net Worth = Fixed Assets / Net Worth

Efficiency:

1. Collection Period = (Accounts Receivable / Sales) × 365
2. Net Sales to Inventory = Annual Net Sales / Inventory
3. Assets to Sales = Total Assets / Annual Net Sales
4. Sales to Net Working Capital = Net Sales / Net Working Capital
5. Accounts Payable to Sales = Accounts Payable / Annual Net Sales

Profitability:

1. Return on Sales (Profit Margin) = Net Profit after Tax / Annual Net Sales
2. Return on Assets = Net Profit after Tax / Total Assets
3. Return on Net Worth (Equity) = Net Profit after Tax / Net Worth

Solvency:

1. Quick ratio reveals the protection afforded short-term creditors in cash or near-cash assets. It reflects the number of dollars of liquid assets available to cover each dollar of current debt. Any time this ratio is greater than or equal to 1, the company is said to be in a liquid condition. *The larger the ratio the greater the liquidity.*

2. Current ratio measures the degree to which current assets cover current liabilities. The higher the ratio, the more assurance there is that the retirement of current liabilities can be made. *Normally a ratio of 2 or better is considered good for manufacturing industries.*

3. Current liabilities to net worth compares the funds that creditors temporarily are risking with the funds permanently invested by the shareholders. *The larger the ratio, the less security there is for creditors. A ratio under 66.6% is considered reasonable.*

4. Current liabilities to inventory yields another indication of the extent to which the company relies on funds from disposal of unsold inventory to meet its debts. *This ratio should be lower than the industry norm to be considered favorable.*

5. Total liabilities to net worth measures the effect of long-term debt on a company. *This ratio should be less than 100%; otherwise, creditors have more at stake than shareholders.*

6. Fixed assets to net worth measures the proportion of net worth that consists of fixed assets. *Generally a smaller ratio (under 75%) is desirable.* A high ratio indicates a heavy investment in fixed assets, requiring large annual depreciation charges to be deducted from the income statement.

Efficiency:

1. Collection period measures the average length of time a company needs to collect its accounts receivable. This indicator should be considered in relation to the firm's credit terms and industry norms. *Any collection period more than one-third over normal selling or credit terms* (e.g., 40 for 30-day terms, 80 for 60-day terms, etc.) *is indicative of slow-turning receivables.*

2. Net sales to inventory measures the rapidity at which merchandise is being moved and the effect on the flow of funds into the company. Good inventory control is critical since inventory can become costly to store, obsolete or insufficient to meet demands. This ratio should be compared with industry norms. *Low ratios are usually the biggest concern as they indicate excessively high inventories.*

3. Assets to sales is an indicator of the assets required to generate the sales. *High percentages compared to industry norms may indicate a more aggressive sales policy is needed.* Low percentages, which are less common, can indicate handling an excessive volume of sales in relation to investment, which may lead to financial difficulties, such as insufficient cash to replenish inventory.

4. Sales to net working capital indicates whether a company is overtrading or, on the other hand, carrying more liquid assets than needed for its volume. High sales volume can cause strains on working capital to the extent that a company will have difficulty meeting its current obligations. *This ratio should be compared to industry norms.*

5. Accounts payable to sales measures how the company is paying its suppliers in relation to the sales volume being transacted. *A ratio higher than the industry norm indicates the firm may be using suppliers to help finance operations, and may indicate potential problems in paying vendors.*

Profitability:

1. Return on sales or profit margin reveals the profits earned per dollars of sales and thus measures the efficiency of the operation. *This ratio is an indicator of a company's ability to withstand adverse conditions such as falling prices, rising costs and declining sales, and should be compared to industry norms.*

2. Return on assets is the key indicator of profitability for a company since it compares operating profits with the assets available to earn a return. *This ratio should be compared with the industry norm.*

3. Return on net worth is used to analyze the ability of the firm's management to realize an adequate return on the capital invested by the shareholders of the firm. Generally, *a ratio of at least 10% is regarded as desirable for providing dividends plus funds for future growth.*

3.3. Alternative Common Financial Ratios.

Financial ratios are also commonly grouped into four similar categories: leverage or debt, liquidity, activity, and profitability. Leverage or debt ratios measure the degree of corporate indebtedness and the

ability to meet the fixed payments associated with the debt. Liquidity ratios measure a firm's ability to meet the fixed payments associated with the debt. Liquidity ratios measure a firm's ability to meet its short-term financial obligations, as they come due. Activity ratios are used to measure how efficiently a company utilizes its resources or assets to generate sales or cash. Profitability ratios measure the effectiveness of management in generating profits with available assets. Formulas for calculating some of the commonly used ratios in these categories are indicated below.

Leverage:

1. Debt to Total Equity = Total Liabilities / Net Worth
2. Times Interest Earned = Earnings before Interest & Taxes / Interest Expense

Liquidity:

1. Current Ratio = Current Assets / Current Liabilities
2. Cash Flow per Share ($) = (Income before Extraordinary Items + Depreciation & Amortization) / Number of Shares

Activity:

1. Operating Cycle = Average Age of Inventory + Average Age of Receivables
2. Fixed Asset Turnover = Sales / Net Fixed Assets

Profitability:

1. Return on Average Total Assets = Net Profit after Taxes / Total Assets
2. Return on Average Total Equity = Net Profit after Taxes / Total Stockholders' Equity
3. Profit Margin = Net Profit after Taxes / Sales

Leverage:

1. **Total liabilities to net worth** is discussed above in the Dun & Bradstreet ratio descriptions.

2. **Times interest earned** measures the ability of the company to meet debt-related fixed charges (interest charges) out of current earnings. *The higher the ratio the better because it indicates a higher margin of safety in meeting its obligations to its creditors.* Failure to meet these obligations could result in bankruptcy or at least cause difficulties in attempts to borrow additional funds.

Liquidity:

1. **Current ratio** is discussed above.

2. **Cash flow per share** measures cash flow from operations per share. This ratio may provide a more accurate picture of the company's true strength than reported earnings per share. Some companies

with good earnings will have low cash flow ratios. This may indicate they have been neglecting capital spending, causing earnings to look better. Companies with high cash flow ratios may be sheltering earnings with heavy depreciation or selling off assets and holding cash in cash reserves. *This ratio should be compared to industry norms.*

Activity:

1. **Operating cycle** is the average amount of time that elapses from the point when the firm makes an outlay to purchase raw materials to the point when cash is collected from the sale of the finished product using the raw material. *This indicator should be compared against industry norms, but generally, lower numbers are better since this implies the company is managing the firm in a fashion that requires minimum cash.* This permits the availability of surplus cash funds for various investments and for repayment of debts.

2. **Fixed asset turnover** is used to measure the efficiency with which the firm has been using its fixed assets to generate sales. *This ratio should be compared to industry norms or the firm's previous performance, but generally, higher fixed asset turnover ratios are preferred.*

Profitability:

Return on assets, return on equity, and return on sales are discussed above in the Dun & Bradstreet ratios.

Chapter 4. OTHER TOOLS FOR ANALYSIS

4.1. Z-Scores.

Use of the Z-Score, also known as Financial Distress Analysis, identifies potential financial distress of contractors. The Z-Score is useful, in conjunction with other available tools, as an additional quantitative index of a firm's financial health. In Army financial analysis, the Navy's Z-Score model for DoD hardware contractors is preferred because it is considered more representative for DoD applications. The Navy model is based on data and analysis of 58 large publicly held firms with significant defense sales. Although still in widespread use today, Altman's financial distress model is not preferred by DoD because of several limitations. The Altman model, developed using data that is now twenty or more years old, lacks precise definitions of the financial ratios employed and rationale for their selection. Also, the overall index is difficult to interpret because it is not scaled to zero.

The Navy Z-Score is a composite rating which provides a single quantitative index of a firm's financial health. The Z-Score model, or formula, follows:

$$Z = 1.5 + (4.6 \times A) - (0.4 \times B) + (9.3 \times C) - (6.5 \times D) - (5.4 \times E) + (1.6 \times F)$$

The variables included in the model are the financial ratios which follow:

A = Cash Flow to Total Debt

B = Current Assets to Current Liabilities

C = Quick Assets to Total Assets

D = Total Debt to Total Assets

E = Working Capital to Total Assets

F = Net Sales to Total Assets

A. Cash flow to total debt measures the ability to pay the cost of debt with cash flow, and is a measure of long term solvency.

B. Current assets to current liabilities, or the current ratio, measures the company's ability to meet its short term obligations as they come due. Generally, the higher the current ratio the better; however, too high a current ratio may indicate that capital is not being used productively in the business.

C. Quick assets to total assets measures the ability of the company to respond quickly to cash requirements, an indication of immediate liquidity.

D. Total debt to total assets, or the debt ratio, indicates the degree to which the company is leveraged. The higher the ratio, the less opportunity for additional borrowing. The lower the debt ratio, the greater the margin of protection for creditors.

E. Working capital to total assets indicates the amount of cash and similar assets available to support on-going operations relative to the total capitalization.

F. Net sales to total assets measures the efficiency of the use of total assets in generating sales. The higher the ratio, the more efficient the company is in utilizing assets. A low ratio compared with industry norms indicates that the assets are probably too great for the sales volume of the corporation.

The Navy model was developed with a scale based on "0." Thus, calculated Z-Scores are interpreted such that firms with negative (less than 0) Z-Scores are considered to be in financial distress, and firms whose Z-Scores are above 2.4 are considered financially healthy. The more positive a firm's Z-Score, the better. Z-Scores falling in the 0 to 2.4 range are considered to be in a zone of uncertainty, which means that financial distress or health cannot be predicted conclusively; further analysis will be required.

Comparison of a firm's Z-Score with the average of those of other major defense contractors is a further indicator of a firm's relative financial condition. Although the Z-Score model should not be relied upon to support a financial condition assessment by itself, it does provide an alert that additional analysis is required. Evaluating a firm's Z-Score trend over time also can provide important insights into a firm's financial health. A declining trend may indicate that the firm is in the early stages of financial distress. The deteriorating financial condition identified by this trend may be more significant than the actual scores.

Z-Scores are considered by some analysts to be predictive of bankruptcy as early as two to five years prior to its occurrence. However, the high correlation between negative Z-Scores and bankruptcy should not be interpreted to mean that all firms with negative Z-Scores are (or will be) bankrupt. No mathematical formula can measure with certainty a company's likelihood of declaring bankruptcy. That decision (though based substantially on quantitative factors) will be made by management, considering many factors. Further, even filing for bankruptcy does not necessarily mean that a firm will stop operating and providing products or services to DoD. But, it does create significant concern as to the future operations of a company and a requirement for careful monitoring.

4.2. Bond Ratings.

A corporate bond is a certificate indicating that a corporation has borrowed a certain amount of money from an institution or an individual and promises to repay it in the future under clearly defined terms. Independent agencies, such as Moody's, Standard & Poor's (S&P), and Fitch's investor services, assess the riskiness of publicly traded bond issues and publish bond ratings. The ratings involve a judgment about the future risk potential of the bond, but several historical factors are significant in their determination. The ratings are derived by use of financial ratio and cash flow analyses. High rated bonds generally provide lower returns to bondholders than low rated bonds, reflecting the risk-return trade-off for the lender.

In financial analysis, bond ratings are useful as another indicator of the financial strength of a corporation. Bond ratings are readily available in publications found in technical libraries, and are especially helpful in quick response analyses. S&P Bond Ratings are retrievable from various data bases, such as the S&P COMPUSTAT® data base (available on a subscription basis), and by definition, translate to a level of capacity to pay principal and interest. For example, an S&P bond rating of AA (level 2 of 11 ratings) indicates that the company has a very strong capacity to pay interest and repay principal. An S&P rating of BBB (level 4 of 11 ratings) is defined to indicate that adverse economic conditions or changing circumstances are likely to lead to weakened capacity on the part of the firm to pay principal and interest. These levels (1 through 11) can be summarized to indicate a brief overall rating of the firm's financial health. For example, with an S&P rating of AA, the firm could be rated as *Very Strong*. Use of bond ratings is illustrated in the sample financial analyses in the Appendixes.

Chapter 5. SOURCES OF FINANCIAL INFORMATION

There are numerous sources of current financial data on most DoD contractors. Companies' annual reports to shareholders and the Security and Exchange Commission (SEC) 10-K annual reports and 10-Q quarterly reports provide the foundation, and are readily available. They all include income statements, balance sheets, statements of changes in stockholders' equity and statements of cash flows, which provide historical financial statistics, company background, CPA audit report, lines of business and customers, review of operations and recent changes, discussion of pending legal disputes, and other information. This company-originated (internal) data is essential, but successful financial analyses also will require data on the industry in which the company resides and data from other external sources. A brief description of internal and external sources of financial data follows:

1. The 10-K Report is the most comprehensive source of information about a company's financial condition and operations. However, it is usually not available until 3 or 4 months after the end of the company's fiscal year.

2. Dunn & Bradstreet, Inc. provides financial data for many firms. The Dun & Bradstreet data base consists of fourteen ratios, with interquartile ranges for about 125 types of businesses. Retrievals from this automated service are available for a fee.

3. Standard & Poor's COMPUSTAT® Services, Inc. is a quickly accessible source of substantial contractor financial data. It includes basic financial data (in the 10-K and 10-Q reports), calculated ratios, trends of key financial variables, and bond ratings, plus a capability for developing non-standard reports. A subscription fee is charged for this service.

4. *Value Line* is an investment advisory publication which offers summaries of firms' financial situation, including historical sales, sales by product line, importance of government sales, an evaluation of the firm's near-term outlook, and projections of financial data for future years. *Value Line* is available in most technical libraries.

5. Moody's Investor Service, Inc. provides information on firms' descriptions and performance data, in its "Handbook of Common Stocks," plus bond ratings in its "Bond Record."

6. *Business Week, Forbes,* and *Fortune* magazines are other sources of current business information, which describe major business trends and events for the national economy, major industries and individual companies. The *Wall Street Journal* is another source which publishes major articles about companies' financial prospects or plans.

7. DoD sources, such as contracting officers, Defense Contract Management Command (DCMC), and Program Manager's Offices, are important sources of information about the status of contractors' existing programs.

Chapter 6. REPRESENTATIVE APPROACHES TO FINANCIAL ANALYSIS

6.1. A Quick Response Approach.

Some decision makers require a quick evaluation of an Army contractor's overall financial condition. Financial data can be obtained from various sources and ratios manually computed. However, access to published financial data through a data base such as Standard and Poor's (S&P) COMPUSTAT® facilitates rapid development of an abbreviated financial analysis to accomplish this type requirement. Through the use of standard reports, selected ratio analysis data can be obtained without any manual computation. For this approach, a formatted report comprising leverage, liquidity, activity and profitability ratios for specific companies for the most current completed fiscal year is selected, along with industry average ratios and historical industry averages. The S&P Bond Rating (also available from data bases such as COMPUSTAT®) is useful in these abbreviated analyses as another indicator of the financial strength of the corporation.

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The ratio analysis data and the bond rating may be documented as reflected in Annex A. This format provides a brief, clear picture of the financial condition of the company. Alternative formats may be used, as long

as the data is arrayed in a way that permits meaningful comparisons and projections. Ratio interpretation and comments are developed through analysis of the ratios and other readily available quantitative data. A one-word description of the overall financial condition of the firm is determined primarily by the S&P Bond Rating, modified by the financial analyst, as required. Quick response, abbreviated analyses of this type should be used with judgment and a degree of caution (see *Limitations of Analysis and Cautions*).

6.2. In-Depth Analysis Approach.

When decision makers require a comprehensive financial analysis and time permits, the in-depth analysis approach is suggested. As a first step, several sources of current financial data should be reviewed and evaluated for applicability. Dun & Bradstreet's data base, Industry Norms and Key Financial Ratios, is particularly useful for in-depth analysis because it provides the fourteen key ratios, with interquartile ranges for about 125 types of businesses. Comparing a firm's performance (based on the ratios) with that of similar companies in its industry provides a more meaningful perspective than evaluating ratios against absolute norms.

Financial statements (e.g., annual reports, income statements, balance sheets, etc.) of the firm(s) to be analyzed are the source of the key business ratios to be used for comparison with the industry norms mentioned above. A computer spreadsheet could be used to calculate ratios from financial report data, and to facilitate displaying the resulting information in a well-arranged format. The industry norms, however, must be obtained from a service, such as Dun & Bradstreet. The ratios of the company versus the ratios of the industry median are then analyzed and interpreted as positive or negative, and evaluated with narrative comments.

In addition to the ratio analysis, a valuable feature of the in-depth financial analysis is the inclusion of additional general information about the firm (e.g., sales volume, employment level, name of CEO, etc.); operating group, subsidiary, and product information; actual financial data (in addition to ratios); trend analysis; and considerable interpretive comments on the financial condition of the firm. These narrative comments are based on information obtained from the annual report, Standard & Poor's, Dunn and Bradstreet's, *Value Line*, and business and economic journals reflecting current operations and conditions.

Qualitative analysis is distinguished from the quantitative analysis described above, by its evaluation of important factors that cannot be precisely measured, such as the caliber of a firm's management or the status of labor relations. Quantitative and qualitative factors **both** must be considered in an in-depth analysis to arrive at sound judgments of a firm's financial performance and status. Annex B includes a typical in-depth analysis.

Chapter 7. LIMITATIONS OF ANALYSIS AND CAUTIONS

Perhaps the most important aspect of financial analysis is the understanding that the outcome will not necessarily be a conclusive judgment regarding the financial condition of the firm. A number of limitations are inherent in the process, and certain cautions should be observed. Some of them follow:

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1. Analysis is limited by the accuracy of the financial information provided by the firm in question. Corporate reports and financial statements are summary level documents and subject to differing interpretations.

2. Accounting practices vary widely among firms and can lead to differences in computed ratios (e.g., differing treatment of inventory valuation and methods of depreciation). Individual firms also may change accounting practices, potentially leading to unexpected ratio trends.

3. Comparison of fiscal performance should include a period of time long enough to provide adequate indication of true performance trends--not temporary ups and downs that are normal in business. If less than four or five years of financial data are available, the conclusions should be couched in terms which specify that limitation.

4. Financial statements, which are the basis of ratio analysis, only present information which can be quantified in terms of money. Qualitative information also is critical to successful analysis.

5. Historical data and trends are not necessarily predictive of future events.

6. Financial ratios are more meaningful when compared against industry norms or over a relatively long period of time.

7. The industry category to which a firm belongs is sometimes difficult to identify when the firm engages in multiple lines of business.

8. Published industry averages are approximations, and may not provide a desirable target ratio or norm. The industry average should be considered a guide to the financial position of the average firm in the industry.

9. A financial statement with very high or very low values for one or more financial elements may be present in an industry sample, causing a disproportionate influence on the industry composite. This is particularly true if the sample is small.

10. A firm's operations may be somewhat unique, even within its own industry. Under these circumstances, comparing the firm with its own historical performance may be more meaningful.

Despite these limitations, financial analysis does provide substantial insight into the motivations and constraints on contractors, which should improve the Army's position in source selection, negotiations, and managing contractors' efforts. In some instances, a financial analysis may result in the government making advance payments, guaranteed loans or taking other actions on behalf of the contractor to protect DoD's interest and ensure accomplishment of a contract.

Chapter 8. USE OF THE PRIMER

For analysts and managers who may not be familiar with financial analysis, this Primer is intended to provide a basis for understanding how financial analysis can assist in the materiel acquisition process and also to serve as a reference document to enhance interpretation of completed financial analyses.

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Additionally, it provides guidelines for obtaining financial data, calculating financial ratios, and accomplishing financial analysis through various approaches. However, since successful financial analysis depends significantly upon the quality of the analyst's experience and judgment, the Primer will not, in and of itself, ensure capable performance of financial analysis.

Financial analysis is performed by a limited number of organizations, including Defense Contract Audit & Analysis within the Office of the Secretary of Defense, Defense Contract Audit Agency, Defense Logistics Agency, and within Army, the Assistant Secretary of the Army for Financial Management and Comptroller

[ASA(FM&C)]. Requests for financial analyses, or assistance with financial analyses, should be directed to the Business Practices Directorate, ASA(FM&C). Questions may be referred to SAFM-RBA, DSN 223-6563 or (703) 693-6563. This Primer will assist field and headquarters analysts and managers in understanding the conclusions of the financial analyses developed by financial analysis organizations, and the limitations of the analyses.

ANNEX A

A QUICK RESPONSE APPROACH

FINANCIAL RATIO ANALYSIS

Company: **Company X**
Symbol: **XX**

As of Year Ended 31 Dec 93

Ratios	SIC: 3663 Industry Ratios Average	5 - Yr Avg	XX	Ratio of Company to Industry Average	Ratio Interpretation
Leverage					
Debt to Total Equity	0.62	0.49	0.05	0.07	Positive
Times Interest Earned	2.40	3.52	50.50	21.04	Positive
Liquidity					
Current Ratio	1.37	1.35	1.23	0.90	Negative
Cash Flow per Share ($)	5.36	5.05	6.00	1.12	Positive
Activity					
Operating Cycle (days)	143.00	138.00	91.00	0.64	Positive
Fixed Asset Turnover	5.50	5.62	6.00	1.09	Positive
Profitability					
Return on Avg Total Assets (%)	3.26	3.62	9.94	3.05	Positive
Return on Avg Total Equity (%)	9.68	10.16	21.14	2.18	Positive
Profit Margin (%)	2.07	2.30	5.02	2.43	Positive

Comments

- US Government (USG) sales in Missiles/Space and Military Transportation segments which account for 21% of sales but loss of $418M.
- Company X has been reducing capital expenditures in 2 USG areas since Dec 92, $496M vs. $661M.
- Leverage is very positive compared to industry average.
- Liquidity is mixed.
- Activity is positive; operating cycle is only 64% of industry average; fixed asset turnover is average.
- Profitability is very positive.
- S&P Bond Rating: AA.
- A very strong capacity to pay interest and repay principal.

OVERALL FINANCIAL CONDITION: STRONG

ANNEX B

IN-DEPTH ANALYSIS APPROACH

Sample Corporation
Business Information Report

for
Department of the Army
U.S. Army Cost and Economic Analysis Center

The views, findings, opinions, and conclusions contained in this document are those of the author(s) and should not be construed as official Department of the Army position, policy, or decision unless so designed by other official documentation.

SAFM-RBA
15 January 1994

Information Sources:
Standard & Poor's COMPUSTAT®
Standard and Poor's NYSE Stock Reports
Dun and Bradstreet's DUNSNET
Sample 1993 Annual Report
Sample 10K and 10Q Reports
The Wall Street Journal
The Teal Corporation®

I - General Information:
Sample Corporation

HQ Address
9999 Anywhere Avenue
Anywhere, NY 10016

Chief Executive
John S. Doe
Tel: (212) 555-1105

Line of Business
Defense Electronics
Aerospace

Started
1958

As of December 31, 1993

Sales Volume
3,335,403,076

Net Worth
$1,187,853,027

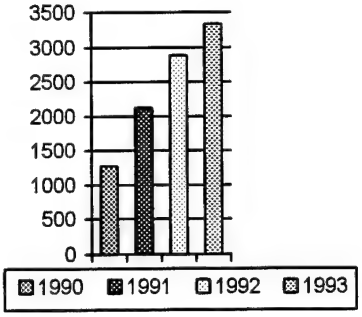
Net Income
($92,083,000)

Employs
24,500

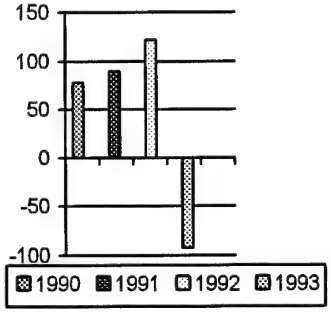
II -- Sample Financial Review

Dollars in millions	1990	1991	1992	1993
Net Sales	$ 1,274	$ 2,127	$ 2,882	$ 3,335
Net Income	$ 78	$ 90	$ 122	($ 92)
Capital Expenditures	$ 61	$ 93	$ 82	$ 97

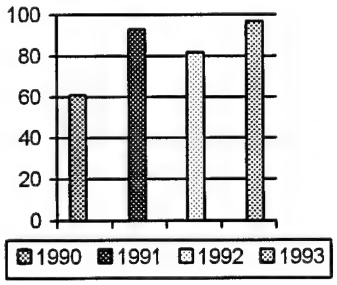
Net Sales
(in millions)



Net Income
(in millions)



Capital Expenditures
(in millions)



Dollars in millions (31 December)	1992	1993	%Change
Total Current Assets	1,204	1,365	13.35%
Total Current Liabilities	608	755	24.08%
Total Assets	2,659	3,228	21.42%
Total Liabilities	1,661	2,040	22.81%
Working Capital	596	611	2.41%
Net Worth	997	1,188	19.10%
Cash	191	117	- 38.83%
Accounts Receivable	674	809	20.11%
Inventory	321	325	1.22%
Fixed Assets	690	782	13.32%
Long Term Debt	562	491	- 12.63%
Accounts Payable	131	151	15.49%
Backlog	2,913	3,851	32.18%
Sales	2,882	3,335	15.74%
Net Income	122	(92)	- 175.61%
Capital Expenditures	82	97	19.29%

III - Sample Financial Ratio Analysis

Solvency	Formula	Standard
1. Quick Ratio	=(Cash + A/R + MS)/(Current Liabilities)	> =1
2. Current Ratio	=(Current Assets)/(Current Liabilities)	> =2
3. Current Liab. to Net Worth(%)	=(Current Liabilities)/(Net Worth)	< 66 %
4. Current Liab. to Inventory(%)	=(Current Liabilities)/(Inventory)	Ind. Norm
5. Total Liab. to Net Worth(%)	=(Total Liabilities)/(Net Worth)	<100%
6. Fixed Assets to Net Worth (%)	=(Fixed Assets)/(Net Worth)	< 5%

(Note: A/R = Accounts Receivable; MS = Marketable Securities)

Efficiency		
1. Collection Period	=((Accounts Receivable)/(Sales))*365	< 33 days
2. Sales to Inventory	=(Sales)/(Inventory)	Ind. Norm
3. Assets to Sales (%)	=(Total Assets)/(Sales)	Ind. Norm
4. Sales to Working Capital	=(Sales)/(Working Capital)	Ind. Norm
5. Accounts Payable to Sales (%)	=(Accounts Payable)/(Sales)	Ind. Norm

Profitability		
1. Profit Margin (%)	=(Income Before Extraordinary Items)/(Sales)	Ind. Norm
2. Return on Assets (%)	=(Income Before Extraordinary Items)/(Total Assets)	Ind. Norm
3. Return on Net Worth (%)	=(Income Before Extraordinary Items)/(Net Worth)	> 10 %

Indicator	1990 Ratio	1991 Ratio	1992 Ratio	1993 Ratio	Industry Norm	Comparison of Company to Industry Norm	4 Year Trend Interpretation
S.1	1.1	1.1	1.4	1.2	1.1	Positive	Up
S.2	1.7	1.6	2.0	1.8	2.3	Negative	Up
S.3	74.6	107.1	61.0	63.5	63.4	Negative	Up
S.4	161.5	197.2	189.6	232.4	108.2	Negative	Down
S.5	162.6	276.8	166.6	171.8	92.0	Negative	Down
S.6	78.3	98.1	69.2	65.8	31.7	Negative	Up
Solvency Comments: Solvency ratios are generally negative when compared to industry norms. The 4 - year trend is up without the exception of Current Liabilities to Inventory and Total Liabilities to Net Worth.							
E.1	103	123	85	89	56	Negative	Up
E.2	4.7	5.8	9.0	10.3	5.9	Positive	Up
E.3	120.5	119.1	92.3	96.8	68.9	Negative	Up
E.4	4.1	4.6	4.8	5.5	4.3	Positive	Up
E.5	10.6	9.2	4.5	4.5	4.5	Negative	Up
Efficiency Comments: Efficiency are mixed when compared to industry norms. The 4 - year trend is up.							
P.1	6.1	4.2	4.2	4.8	2.8	Positive	Down
P.2	5.1	3.6	4.6	4.9	3.8	Positive	Down
P.3	13.3	13.4	12.2	13.4	10.1	Positive	Up
Profitability Comments: Profitability ratios are positive when compared to industry norms. The 4 - year trend is down with the exception of Return on Net Worth.							

IV - Sample Corporation
Financial Analysis Report

Sample Corporation was incorporated in New York on February 24, 1958. The corporation's principal business areas include command, control, communications, and intelligence training, electronic combat; space; reconnaissance; and tactical weapons and guidance. Sample's defense and aerospace activities take place in over 19 divisions and subsidiaries in several states with the main office located in New York, NY.

During fiscal year 1993, Sample ranked 15th among contractors performing work for the Pentagon with $1.8 billion in contract awards. The U.S. Government sales during fiscal year 1993 totaled $2.1 billion, an increase of 36% from fiscal year 1992's $1.5 billion. The increase was attributed largely to the acquisition of Noname missile operations. Approximately, 80% of Sample's sales are to the Federal Government. Overall sales from fiscal year 1992 to fiscal year 1993 were up 16%, an increase of $454 million. Sales for Sample have consistently improved over the past four years. From fiscal year 1990 through fiscal year 1993, sales increased by $2.1 billion.

Solvency ratios are generally negative when compared to industry norms, but the 4-year trend is up with the exception of Current Liabilities to Inventory and Total Liabilities to Net Worth. A decline in interest expense reflects debt reduction. The Standard & Poor's Senior Debt Rating for Sample is BBB+, which is considered adequate approaching strong.

Efficiency ratios are mixed when compared to industry norms and the 4-year trend is up. Sample's collection period is 33 days longer than the industry norm of 56 days. The company's order backlog is $3.8 billion as of December 31, 1993, an increase of $937 million since fiscal year 1992.

Profitability ratios are positive when compared to industry norms. The 4-year trend is down with the exception of Return on Net Worth. However, trends are up since fiscal year 1990. From fiscal year 1990 through fiscal year 1992, net income increased by about $44 million. Sample experienced a 175% decrease in net income from fiscal year 1992 to fiscal year 1993, a loss of $92 million. The loss was primarily the result of changes in accounting rules. Without the extraordinary item, net income would have been $169 million. Strong Returns on Net Worth indicate that Sample is a profitable company. A recent contract for the MLRS should help achieve higher earnings in the future.

Sample is taking significant steps to complete in the global economy by expanding and diversifying its program base, upgrading existing systems rather than developing new ones, and targeting foreign markets. Recent acquisitions include Noname Missiles (September 1992) and Zolt Breakneck & Newsome Simulation business (May 1993). The company will manufacture two direct-to-home broadcast satellites for cable operator Tell-Tale Storybrook, Incorporated to be delivered June and October 1996. Some industry analysts predict that Sample will improve its flow through March 1994.

GLOSSARY

Section I - Abbreviations

AAA	Army Audit Agency
AAE	Army Acquisition Executive
AC	Active Component
ACAT	Acquisition Category
ACAT IA	Acquisition Category IA (Major Automated Information System)
ACAT IAM	ACAT IA Major Automated Information Systems Review Council (MAISRC)
ACAT IAC	ACAT IA Component
ACP	Army Cost Position
ADARS	Army Defense Acquisition Regulation Supplement
ADM	Acquisition Decision Memorandum
ADP	Automated Data Processing
AE	Acquisition Executive
AIS	Automated Information System
AMC	Army Materiel Command
AMCOS	Army Manpower Cost System
AMSCO	Army Management Structure Code
AOA	Analysis of Alternatives
APB	Acquisition Program Baseline
APG	Army Program Guidance
APPIS	Army POM Preparation Instructions Supplement
AR	Army Regulation
ARNG	Army Reserve National Guard
ARSTAF	Army Staff
ASA(FM&C)	Assistant Secretary of the Army (Financial Management and Comptroller)
ASARC	Army Systems Acquisition Review Council
ASA(RDA)	Assistant Secretary of the Army (Research, Development, and Acquisition)
ASD(C3I)	Assistant Secretary of Defense for Command, Control, Communications, and Intelligence
ASL	Authorized Stockage List
AWCF	Army Working Capital Fund
BAQ	Basic Allowance for Quarters
BAS	Basic Allowance for Subsistence
BASOPS	Base Operations
BCR	Benefit/Cost Ratio
BES	Budget Estimate Submission
BIR	Benefit/Investment Ratio
BP	Basic Pay
BRAC	Base Realignment and Closure
BY	Budget Year
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CAB	Cost Analysis Brief
CAIG	Cost Analysis Improvement Group

CAIV	Cost as an Independent Variable
CARD	Cost Analysis Requirements Description
CCA	Component Cost Analysis
CCDR	Contractor Cost Data Reporting
CDF	Cost Documentation Format
CEAC	Cost and Economic Analysis Center
CER	Cost-Estimating Relationship
CES	Cost Element Structure
CFSR	Contract Funds Status Report
CINC	Commander in Chief
CIO	Chief Information Officer
CLIN	Contract Line Item Number
CONUS	Continental United States
CPA	Chairman Program Assessment
CPR	Cost Performance Report
CPUC	Current Procurement Unit Cost
CRB	Cost Review Board
CSA	Chief of Staff, Army
C/SSR	Cost/Schedule Status Report
CTA	Consolidated Table of Allowances
CY	Current Year
DA	Department of the Army
DAB	Defense Acquisition Board
DAE	Defense Acquisition Executive
DAP	Defense Acquisition Program
DCAA	Defense Contract Audit Agency
DCMC	Defense Contract Management Command
DCP	Decision Coordinating Paper
DCSOPS	Deputy Chief of Staff for Operations and Plans
DFSC	Defense Financial Services Center
DISC4	Director of Information Systems for Command, Control, Communications, and Computers
DMRD	Defense Management Review Decision
DoD	Department of Defense
DoDD	Department of Defense Directive
DoDI	Department of Defense Instruction
DPAE	Directorate of Program Analysis and Evaluation
DPRB	Defense Planning and Resources Board
CAIV	Cost as an Independent Variable
ECP	Engineering Change Proposal
EIC	End Item Code
EUSA	Eighth U.S. Army
FDT	First Destination Transportation
FFP	Firm Fixed Price
FIA	Force Integration Analysis
FORCES	Force and Organization Cost Estimating System
FORSCOM	Forces Command
FY	Fiscal Year
FYDP	Future Years Defense Program

G&A	General and Administrative
GAO	General Accounting Office
GSA	General Services Administration
HQDA	Headquarters, Department of the Army
ICE	Independent Cost Estimate
ICS	Interim Contractor Support
ILS	Integrated Logistics Support
IOT&E	Initial Operational Test and Evaluation
IPA	Integrated Program Assessment
IPR	In-Process Review
IPS	Integrated Program Summary
LCC	Life Cycle Cost
LCCE	Life Cycle Cost Estimate
LCM	Life Cycle Management
LIA	Logistics Impact Analysis
LIN	Line Item Number
LOC	Lines of Code
LRIP	Low-Rate Initial Production
RDA Plan	Research, Development, and Acquisition Plan
MACOM	Major Command
MAIS	Major Automated Information System
MAISRC	Major Automated Information System Review Council
MBI	Major Budget Issue
MCA	Military Construction, Army
MDAP	Major Defense Acquisition Program
MDEP	Management Decision Package
MFP	Major Force Program
MNS	Mission Need Statement
MOE	Measures of Effectiveness
MOP	Measures of Performance
MOS	Military Occupational Specialty
MPDI	MACOM POM Development Instruction
MS	Milestone
MTOE	Modified Table of Organization and Equipment
NDI	Nondevelopment Item
NET	New Equipment Training
NSN	National Stock Number
NTC	National Training Center
O&M	Operations and Maintenance
O&S	Operating and Support
OASA(FM&C)	Office of the Assistant Secretary of the Army (Financial Management and Comptroller)
OASA(RDA)	Office of the Assistant Secretary of the Army (Research, Development, and Acquisition)
OCONUS	Outside the Continental United States
ODCSOPS	Office of the Deputy Chief of Staff for Operations and Plans
ODISC4	Office of the Director of Information Systems for Command, Control, Communications, and Computers
OMA	Operations and Maintenance, Army
OMB	Office of Management and Budget

OPTEMPO	Operating Tempo
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
OSMIS	Operating and Support Management Information System
PAVC	Program Acquisition Unit Cost
PBD	Program Budget Decision
PBG	Program and Budget Guidance
PC	Personal Computer
PCS	Permanent Change of Station
PDM	Program Decision Memorandum
PE	Program Element
PEG	Program Evaluation Group
PEO	Program Executive Officer
PEP	Producibility Engineering and Planning
PLL	Prescribed Load Lists
PM	Program Manager
PME	Prime Mission Equipment
POE	Program Office Estimate
POL	Petroleum, Oil, and Lubricants
POM	Program Objective Memorandum
PPBERS	Program Performance and Budget Execution Review System
PPBES	Planning, Programming, Budgeting, and Execution System
PPI	POM Preparation Instructions
PSA	Principal Staff Assistant
PWD	Procurement Work Directive
PY	Prior Year
R&D	Research and Development
RC	Reserve Component
RDT&E	Research, Development, Test, and Evaluation
RFP	Request for Proposals
RIF	Reduction in Force
RPA	Retired Pay Accrual
RPMA	Real Property Maintenance Activity
ROR	Rate of Return
SA	Secretary of the Army
SAP	Special Access Program
SAR	Selected Acquisition Report
SCP	System Concept Paper
SDP	System Decision Paper
SECDEF	Secretary of Defense
SIO	Standard Installation Organization
SIR	Savings/Investment Ratio
SRC	Standard Requirement Code
SSN	Standard Study Number
STP	Short-Term Project
SVP	Special Visibility Program
TAA	Total Army Analysis
T&M	Time and Materials
TAP	The Army Plan

TBD	To Be Determined
TDA	Table of Distributions and Allowances
TOA	Total Obligation Authority
TOE	Table of Organization and Equipment
TRADOC	Training and Doctrine Command
TSG	The Surgeon General
UAC	Uniform Annual Cost
UCR	Unit Cost Report
USAISC	U.S. Army Information Systems Command
USAR	U.S. Army Reserve
USAREUR	U.S. Army, Europe
USARJ	U.S. Army, Japan
USD(A&T)	Under Secretary of Defense (Acquisition & Technology)
VAMOSC	Visibility and Management of Operating and Support Costs
VCSA	Vice Chief of Staff, Army
VEF	Variable Explanation Format
VHA	Variable Housing Allowance
WBS	Work Breakdown Structure
WESTCOM	Western Command

Section II - Terms

Acquisition strategy
Conceptual framework for conducting materiel acquisition, encompassing broad concepts and objectives that direct and control overall development, production, and deployment of system.

Alternative
One of two or more approaches, programs, or projects that are the means of fulfilling a stated objective, mission, or requirement.

Alternative cost
The total cost associated with developing, producing, fielding (including military construction), and sustaining the system. The alternative cost also includes the phaseout cost of the status quo. It does not include sunk cost.

Appropriation
A legislative process setting aside a designated amount of public funds for a given purpose. Jointly, the Senate Appropriations Committee and House Appropriation Committee annually establish funding levels through an appropriations bill, which ultimately is enacted into law upon signing by the President.

Army Acquisition Executive
The Secretary of the Army designated principal advisor and staff assistant for acquisition of Army systems. The Assistant Secretary of the Army for Research, Development, and Acquisition is currently designated as the Army Acquisition Executive responsible for overall management of Army acquisition programs.

Army Cost Position
The results of the comparative analysis of the Program Office Estimate or Economic Analysis and the Component Cost Analysis or a joint IPT estimate that is documented in the Cost Analysis Brief and

approved by the Assistant Secretary of the Army for Financial Management and Comptroller. It is the approved cost position for all subsequent programming, budgeting, and cost analysis activities.

Army Systems Acquisition Review Council
A panel composed of regular, special members, and participants designated by the chairman whose mission is to review DoD major programs and DAPs at specific milestones and provide Army approval prior to the next phase of system acquisition.

Assumption
A statement or hypothesis made concerning unknown factors and data that are required to accomplish the analysis. Assumptions should never be confused with facts.

Benefit
Results and outputs expected in return for costs and inputs incurred or used. A positive output of an alternative. It includes measures of utility, effectiveness, and performance. Benefits focus on the purpose and the objectives of a project.

Benefit/cost ratio
The ratio of the present value of the total benefits (savings and cost avoidances) divided by the present value of the total costs. It does not include sunk cost. A benefit/cost ratio (BCR) of 1.0 indicates that the present value of the benefits is equal to the present value of the total costs. The calculation for BCR begins by applying the discount factor to the constant-dollar benefits and the constant-dollar costs to arrive at the present value of the total benefits and the present value of the total costs.

Benefit/investment ratio
The ratio of the present value of the dollar quantifiable benefits (savings and cost avoidances) divided by the present value of the investment (development, production, military construction, and fielding) cost of the alternative. It does not include benefits that are associated with sunk cost. A benefit/investment ratio of 1.0 indicates that the present value of the benefits is equal to the present value of the investment. The calculation begins with constant dollars.

Break-even point
The point, for example, number of years or fractional years, at which the savings in current dollars equals the investment in current dollars. It does not include sunk cost.

Common costs
Common costs are cost element estimates which will be the same regardless of the alternative selected. In instances where this occurs, common costs must be identified and included in the life cycle cost estimate of all feasible alternatives for accomplishing the mission objective.

Component Cost Analysis
A complete and fully documented life cycle cost estimate for a system that is developed external of and independent from the acquisition proponent or a independent estimate of major cost drivers and or cost elements. The Component Cost Analysis is used to test the reasonableness of the POE/EA and provide a second opinion of the system's cost.

Constant dollars
All prior year, current, and future costs that reflect the level of prices of a base year. Constant dollars have the effects of inflation removed.

Cost analysis
The act of developing, analyzing, and documenting cost estimates through various analytical approaches and techniques. It is the process of analyzing and estimating incremental and total resources required to support past, present, and future systems. In its application to future resource requirements, it becomes an integral step in selection of alternatives by the decision maker.

Cost Analysis brief
A Cost Review Board-originated document that presents a comparative analysis between the Program Office Estimate/Economic Analysis and the Component Cost Analysis. It documents the contrasting methodologies between the two estimates, explains major cost differences, and is used to document the Army Cost Position.

Cost Analysis Improvement Group
An OSD committee which serves as the principal advisory body to the Defense Acquisition Board on matters related to cost estimates.

Cost avoidances
All reductions in future resource requirements, not in an approved Army program, because investment in some needed program/project will not have to be made. For example, there is a cost avoidance if the status quo has a plan that requires the purchase of certain hardware that has not been included in an approved Army program, but the implementation of the preferred alternative does not require the purchase of the hardware and does not degrade current capability. Cost avoidances are a quantifiable benefit.

Cost driving variable
A parameter, such as speed, range, peak power levels, that has a major or significant effect on the cost.

Cost estimate
a. A prediction of costs consisting of:
   (1) A clearly defined requirement.
   (2) A statement of cost assumptions.
   (3) A source identification for basic cost data.
   (4) A documentation of the methodologies used.

b. The estimated cost of a component or aggregation of components that is developed by using historical cost data and/or mathematical models.

Cost-estimating relationship
A mathematical expression relating cost as the dependent variable to one or more independent cost-driving variables. The expression may be represented by several functions, such as linear, power, exponential, and hyperbolic.

Cost factor
A cost-estimating relationship where the cost estimate is determined by performing a mathematical operation on some other related cost element. It is a brief arithmetic expression where cost is determined by application of a factor such as a percent, and so on.

Cost reduction

A decrease in elements of cost between the status quo and one of the feasible alternatives that results from a variation in operations. For example, the requirement for supplies may decrease as a result of a change in operations.

Current dollars
Dollars that reflect the purchasing power of the dollar in the year the cost or savings is to be realized or incurred. That is, current dollars reflect the effects of inflation. Prior-year costs stated in current dollars are the actual costs incurred in those years. Future costs or savings stated in current year dollars are the projected values that will be paid out in the future years.

Defense Acquisition Board
A senior DoD corporate body for systems acquisition that provides advice and assistance to the DAE and the Secretary of Defense.

Defense acquisition program
A program designated by OSD management or the AAE for DAB or ASARC review.

Discounting
A technique for converting various annual cash flows occurring over time to equivalent amounts at a common point in time, considering the time value of money, to facilitate comparison. (This is an alternative definition of present value.)

Discount rate
The interest rate used to discount or calculate future costs and benefits so as to arrive at their present values. This term is also known as the opportunity cost of capital investment. OMB Circular A-94 presently uses a discount rate tied to the Government's cost of capital.

Economic Analysis
a. A systematic approach to identify, analyze, and compare costs or benefits of alternative courses of action that will achieve a given set of objectives. This approach is taken to determine the most efficient and effective manner to employ resources. In the broad sense, the systematic approach called economic analysis applies to new programs as well as to the analysis of ongoing actions.
b. A complete, detailed, and fully documented analytical study in which the economic analysis approach is used.

Economic life
The period of time over which the benefits to be gained from deployment or use of a resource may be reasonably expected to accrue. The economic life of a project begins in the year it starts producing benefits and ends when the project no longer accomplishes its primary objective.

Independent assessment/sufficiency review
An evaluation and validation of the PEO's and PM's cost or economic analysis, short of performing a full CCA, for a program scheduled to be reviewed by the ASARC or Army MAISRC. This review includes a thorough analysis of the problem definition, alternatives, assumptions, cost estimate, benefit analysis, risks, conclusions, and recommendations.

Independent cost estimates

A complete and fully documented life cycle cost estimate for a system that is developed external of and independent from the acquisition proponent. The ICE is used to test the reasonableness of the BCE/EA and provide a second opinion of the system's cost.

Information systems
Organized assembly of resources and procedures designed to provide information needed to execute or accomplish a specific task or function. It applies to those systems that evolve, are acquired, or are developed that incorporate information technology. It applies to all five Information Mission Area disciplines and encompasses AIS. Information system equipment consists of components to create, collect, process, store, retrieve, transmit, communicate, present, dispose, and/or display information.

Inherited assets
Operational equipment or software that becomes part of a system irrespective of original funding or "ownership."

In-process review
Review of a project or program at critical points to evaluate status and make recommendations to the decision authority; accomplish effective coordination; and make cooperative, proper, and timely decisions bearing on the future of the project.

Investment cost
Includes the research and development phase and the production and deployment phase (to include military construction) costs of the system.

Life cycle cost estimate
A document that:

a. Includes all costs incurred during the total life (from project initiation through termination) of a system or aggregation of systems.

b. Includes cost for research and development, production, military construction, deployment, and operating and support.

Major system

a. Systems estimated by the Secretary of Defense to require a total expenditure for RDT&E of more than $200 million (FY 80 constant dollars) or an eventual total expenditure for procurement of more than $1 billion (FY 80 constant dollars).

b. Materiel system acquisition programs recommended by HQDA to be managed as MDAPs or ADAPs. Designation is normally a part of the required operational capability.

c. Army systems designated by the Secretary of Defense for DAB review are automatically identified as Army major systems.

Management Decision Package
A structured life cycle process that represents the most current approved funding position developed through the PPBES. A separate MDEP will normally be created for each major system. Each MDEP covers a 9-year period.

Materiel system
A combination of hardware components that function together as an entity to accomplish a given objective. A materiel system includes the basic items of equipment, support facilities, and services required for operation and sustainment.

Milestone decision review
An event (meeting) composed of top military and civilian managers, including the program manager. Its purpose is to address and resolve major program issues before approval is granted to proceed to the next life cycle management phase.

Net present value
The difference between the present value of the benefits and the present value of the costs.

Nonquantifiable benefits
A benefit that does not lend itself to numeric valuation, such as better quality of services. Nonquantifiable benefits are to be addressed in narrative form in the documentation.

Operating tempo
The annual operating miles or hours for systems in a particular unit required to execute the commander's training strategy.

Payback period
The number of years required for the cumulative savings to equal the cumulative investment costs (development, procurement, military construction, and fielding) in current dollars. The payback period is normally stated in nondiscounted terms; however, a discounted payback period may also be shown.

Phaseout cost
That cost required for the parallel operations of the status quo while the new system is being developed, fielded, and accepted. This cost occurs from the time the development of the new system begins to when fielding is completed.

Present-value dollars
Dollars that have had their annual cash flow occurring over time converted to equivalent amounts at a common point in time in order to account for the time value of money. The normal discount rate is 7% , as prescribed by OMB. The computation begins with constant dollars.

Productivity improvements
Cost avoidances that are in the form of personnel time savings and are dollar quantified, and that do not represent an opportunity to reduce a force structure or MDEP.

Program baseline
A description of a specific program containing the following key elements:

a. Requirements. A concise statement of prioritized functional needs.

b. Program content. A concise description of the program capabilities and products to be provided, including required technical and operational characteristics, within the approved funding.

Program cost
Consists of research and development, procurement, and deployment (includes military construction) costs (including sunk) that are in direct support of the system or project. Included within this definition are operations and maintenance funds for expenditure directly related to concept development, design, and deployment. Program cost and program acquisition cost are synonymous terms.

Program/project/product manager

An individual assigned the responsibility and delegated the authority for the centralized management of a specific system acquisition program/project/product.

Program Office Estimate
A complete, detailed, and fully documented materiel system life cycle cost estimate updated throughout the acquisition cycle and the Planning, Programming, Budgeting, and Execution System. The Program Office Estimate, as accepted or modified by the Army Cost Position, provides the basis for subsequent tracking and auditing.

Quantifiable benefit
A benefit that can be assigned a numeric value, such as dollars, physical count of items, or percentage change.

Rate of return
The discount rate at which the present value of the investment cost equals the present value of the savings. The calculation begins from constant dollars. The ROR does not include sunk cost.

Savings
A cost reduction (to include civilian whole spaces) that will be made in a specific MDEP resulting from implementing a specific alternative that does not degrade current capability, in lieu of continuing the present system. The savings will be specifically identified. Savings are a quantifiable benefit. For example, if the implementation of an alternative way of doing business does not consume as much paper as the previous way of doing business, there is a savings, because an MDEP can be reduced by the amount of paper that does not have to be purchased. Likewise, if the new alternative reduces the number of civilians required to perform the mission and those civilian spaces are terminated, there is a savings because an MDEP can be reduced by the amount required to employ that manpower. If military manpower can be specifically identified to a force reduction, there is a savings. If the military manpower cannot be identified to a specific force reduction, there is a cost avoidance. There must be a program reduction for a savings to occur; thus, benefits are considered as savings only if the estimate identifies benefits that start accruing during the POM period and end during the POM period. If the estimate identifies benefits that accrue beyond the POM period, the benefits are considered as cost avoidances.

Savings/investment ratio
The ratio of the present value of the savings to the present value of the investment required to produce the savings. It does not include sunk costs. An SIR of 1.0 indicates that the present value of the savings is equal to the present value of the investment. The calculation begins with constant dollars.

Sunk costs
Sunk (past or unavoidable) costs are past expenditures or irrevocably committed costs that are not avoidable and, therefore, should not be considered in the decision process.

System
A combination of all components and tangible items that function together as an entity to accomplish a given objective.

System-specific cost
Hardware, software, and related costs that can be directly attributable to a particular system.

Uniform annual cost

A measure of the relative cost of a project that represents the average yearly cost, and is derived from the total discounted cost figure. The average yearly cost (UAC) is the total project cost discounted, divided by the sum of the discount factors for the years in which the system provides benefits (economic life).

Validation
A review of all elements in a cost estimate to confirm that they are sound, developed using acceptable cost estimating methods, adequately documented, and capable of being justified, supported, and defended. The validation will be performed by an organization external and independent from that of the functional proponent and preparer of the estimate.

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